ENVIRONMENTAL QUARTERLY

July • 1960

The Pioneer Space Age Publication of Environmental Simulation, Testing, Engineering and Equipment Manufacturing

INDEPENDENTLY PUBLISHED

Volume 6 • Number 3

LING'S LIQUID-COOLED SHAKERS DISSIPATE HEAT FAST WITH WATER

Improved system efficiency goes with the improved design of Ling's new series of liquid-cooled shakers. For instance, Model 349 shown above not only offers an impressive 28,000 pound force rating, but a number of other advantages. The new closed-loop cooling system, employing clean raw or distilled water, dissipates heat so efficiently that less is dumped on the testing site. The series also features a new web-design armature of lightweight aluminum. Force is transmitted to the table with maximum rigidity. Finally, special construction details make these liquid-cooled shakers adaptable for environmental chamber testing without special accessories. Tests can be conducted from −100°F to 300°F at any altitude. Field and armature coils are designed to help eliminate corona at altitudes; special thermal barriers can be supplied which control heat flow from the shaker to the chamber. This built-in adaptability and high efficiency grow from Ling research; For details on the liquid-cooled shaker series, write Dept. EQ-3 at either address below.

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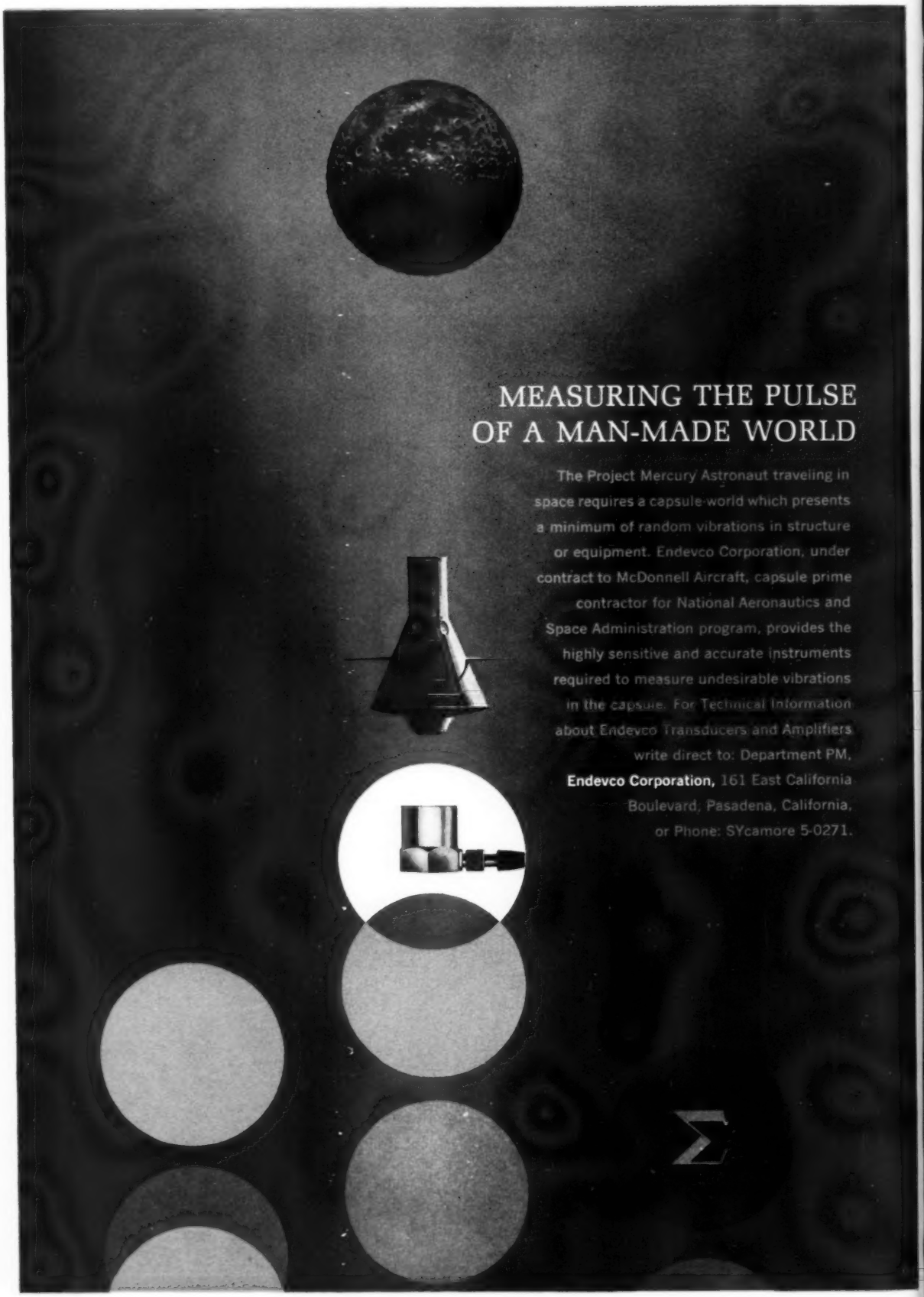
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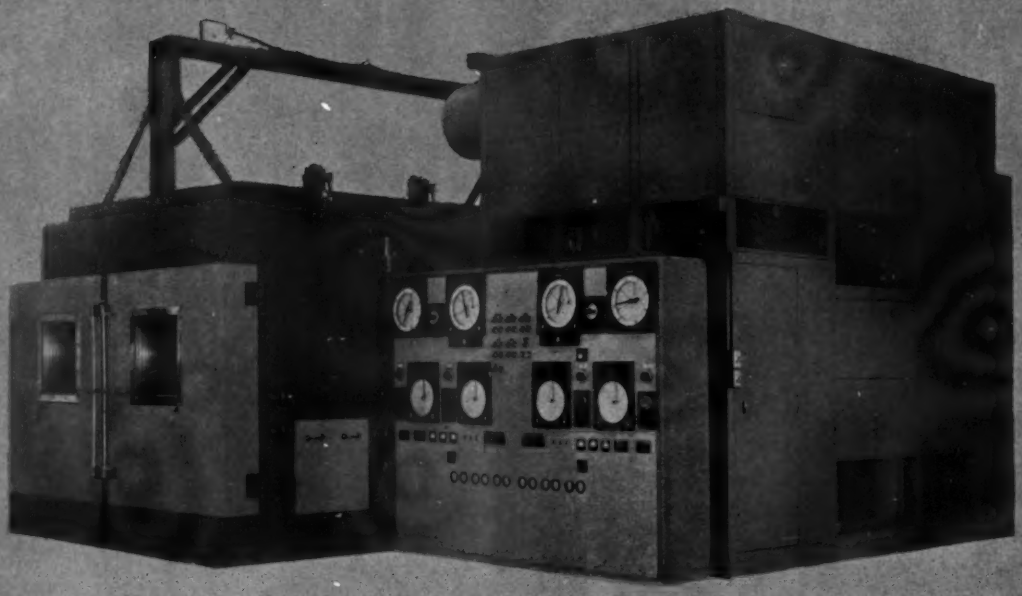
NEW Hyper Environment Chamber for Thermal Shock Tests



Model WD-585-50-50-50-50

Simulates Missile Re-entry Problems

Recently completed for a government agency, this Conrad hyper environment chamber offers unusual flexibility. It may be used as a single large test chamber, or as two smaller chambers operating simultaneously at widely separated temperatures.

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Conrad is continually at work on custom chambers as well as stock models. Take advantage of this leadership. Call in Conrad on your next chamber requirements.

Write For Literature

Temperature in each section is individually controlled from —100°F. to +500°F. Test components are transferred from section to section through the use of special carts, rails, and turntables.

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CONRAD Inc.

HOLLAND, MICHIGAN

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Quarterly welcomes competent expressions of opinion, but statements in its pages do not necessarily reflect its views. Right is reserved to extract portions of letters and other material submitted for publication. Correspondents must be fully identified, but names will not be published if such a request is made.

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ENVIRONMENTAL QUARTERLY

The Pioneer Space Age Publication of Environmental Simulation, Testing, Engineering and Equipment Manufacturing

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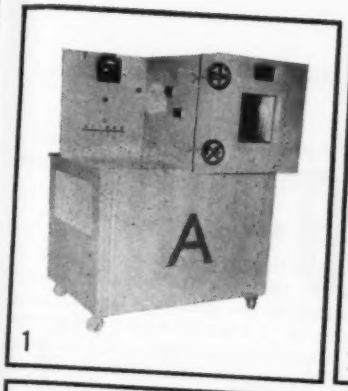

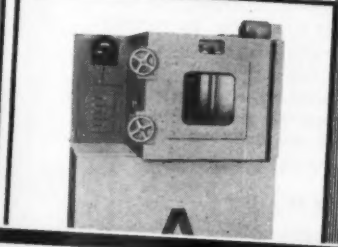

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Post Scripts

An important part of the environmental get-together in Los Angeles last April was the meeting of the Environmental Equipment Institute (See "Environmental Business").

Measured in numbers or dollars, the EEI may be a comparatively small trade association, but in terms of ideas, aims and importance of product it ranks with the biggest and the best.

Environmental Quarterly asked Jack Shamroth, newly elected president of the EEI, to discuss the plans and objectives of his administration. He responded as follows:

"The small group of competitors who formed the Institute set out to win recognition for an industry. I believe it has succeeded.

"When we first met, few persons had ever heard of an Environmental Engineer. We were lucky to be able to read an occasional article on environmental testing in any publication. We were competitors, each busy fighting his own particular brush fires.

Recognition Achieved

"In less than a decade we have seen the growth of a national professional organization devoted exclusively to our engineering specialty. Time and again now, environmental testing is written up in newspapers and general interest magazines, to say nothing of exclusively environmental and other technical publications. Today we are competitors working together for the good of our industry and the advancement of the science we serve.

"What are our plans for the coming year? With the big project of establishing the identity of our industry behind us, our efforts for the immediate future should be concentrated on consolidating our gains.

"We are still working hard to be leaders in accepting the responsibilities of a growing industry. We are strongly commited to the notion that a manufacturer must stand behind his products. Consequently any complaints against any member will be thoroughly investigated by the EEI. At the same time we plan to keep up present services to our members, and to increase these services whenever practical.

Continued Support to IES

"Individually, our members will continue to give local support to the Institute of Environmental Sciences, and as a group we shall lend whatever help is needed to the IES program.

"Our most important program is one I hope will never be needed. Our industry may be small, but it is vital to national defense. In case of any emergency, our organization, as the only group of manufacturers in the industry, will be the clearing house for any industry-wide coordination that may be necessary.

"We did not have such a clearing house in World War II. Our industry was in its infancy then, but now it is more mature. We must accept the responsibilities that go with growing up.

Essential to Defense

"If for no other reason, this makes EEI essential. As I said, I hope we never need to implement this program, but if the government requires a single agency for coordinating industry efforts, we are ready.

"As president of the EEI, I am, of course, interested in enlarging our membership. If EEI is good for my company, it is good for every other manufacturer of environmental test equipment. We speak as the responsible segment of our industry. We welcome all good manufacturers of all types of environmental test equipment who have not yet joined us."

Man in Space: A Stunt?

Putting a man in space is a stunt with little military or scientific value.

That's what Dr. Vannevar Bush, of MIT, reportedly told a closed meeting of the House Committee on Science and Astronautics.

In space, he said, a man can do no more than an instrument, and probably far less, and he added:

"There are far more serious things to do than to indulge in stunts."

We Continue to Grow

Environmental Quarterly provides strong evidence of the environmental vitality of which Mr. Shamroth speaks. So far this year, issues of *EQ* have been 33 to 45 per cent bigger than last year's, with a much greater margin over 1958's. Editorially, we are proud to say, *EQ* is without peer.

Although the circulation of this issue is announced as 6,000, it actually has passed that number, for a whopping gain of more than 50 per cent in less than a year and a half.

Who are these new readers? Some are newcomers, so to speak, to environmental testing, reflecting the spread of the Environment in all areas of industry. Many have been in environmental work right along but did not feel the kinship they now feel, thanks to the promotional work of Quarterly, the IES and the EEI. All new readers of Quarterly are screened carefully for their close association with the industry.

Typical of the letters Quarterly receives from those seeking to become readers is the following of April 13 from C.J.K., a Chicago R&D engineer:

"Have seen my first copy of *Environmental Quarterly*. It has to be a must on reading list . . . We do a great deal of environmental testing on lightning arresters which we design and manufacture for major airplane and airline companies."

A Most Successful Show

In this issue is Quarterly's extensive report of the 1960 IES meeting, further evidence of the growth of the Environment. In a letter to Quarterly, Charles F. Conrad, vice president and sales manager of Conrad, Inc., Holland, Mich., manufacturer of environmental test chambers, summed up his reaction to Los Angeles as follows:

"I would like to use this means of complimenting all of the officers and assistants concerned with the Institute of Environmental Sciences meeting and exhibit April 6-9 at the Biltmore Hotel.

"This meeting was one of the most successful and educational to date. Publishing the papers presented and distributing these at the meetings proved to be especially helpful. Each year these symposiums are of increasing value. We are all looking forward to the 1961 conference."

Getting Things Straight

To err, it is said, is human—but embarrassing nonetheless. Quarterly's apologies, therefore, for the upside-down photo that crept into Page 41 of the April issue in a new product report. Herewith is how the product, Blue M Electric Company's Power-O-Matic 60 mechanical convection oven, appears to everyone except our printer who, as devotees of Gutenberg's art know, works upside-down anyway. In the words of Frank Marsillo, advertising manager for Blue M, "one can assume an oven door is opened from left to right, (and) moreover, a unit of this kind cannot be useful at ground level."

Blue M's POM 60
Right side up

It isn't always the printer or editor who goofs. In recent months two readers have sent in EQ's popular reader service cards without giving name and address. One, a card from our January issue with five numbers and letters circled, came from Renton, Wash. The other, asking for reprints of "Practical vs. the Ideal" and "Primer on Piezoelectric Accelerometers," had a Poughkeepsie, N. Y. postmark. We shall be happy to oblige upon hearing further from these readers.

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A

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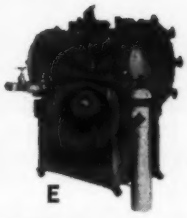
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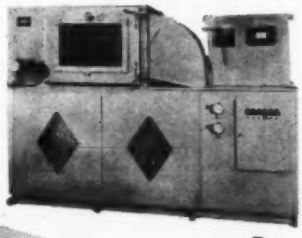
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F

A. SHOCK
Peak accelerations to 700 g's . . . impact duration from 32 milliseconds to 0.1 microsecond. A wide variety of instrumentation is available for measuring all required parameters.

B. VIBRATION
Electrodynamic type exciters and mechanical shakers are capable of performing environmental vibration tests for R & D or production work. Up to 2500 lbs. of force;—120 F to 500 F; altitudes to 200,000 feet.

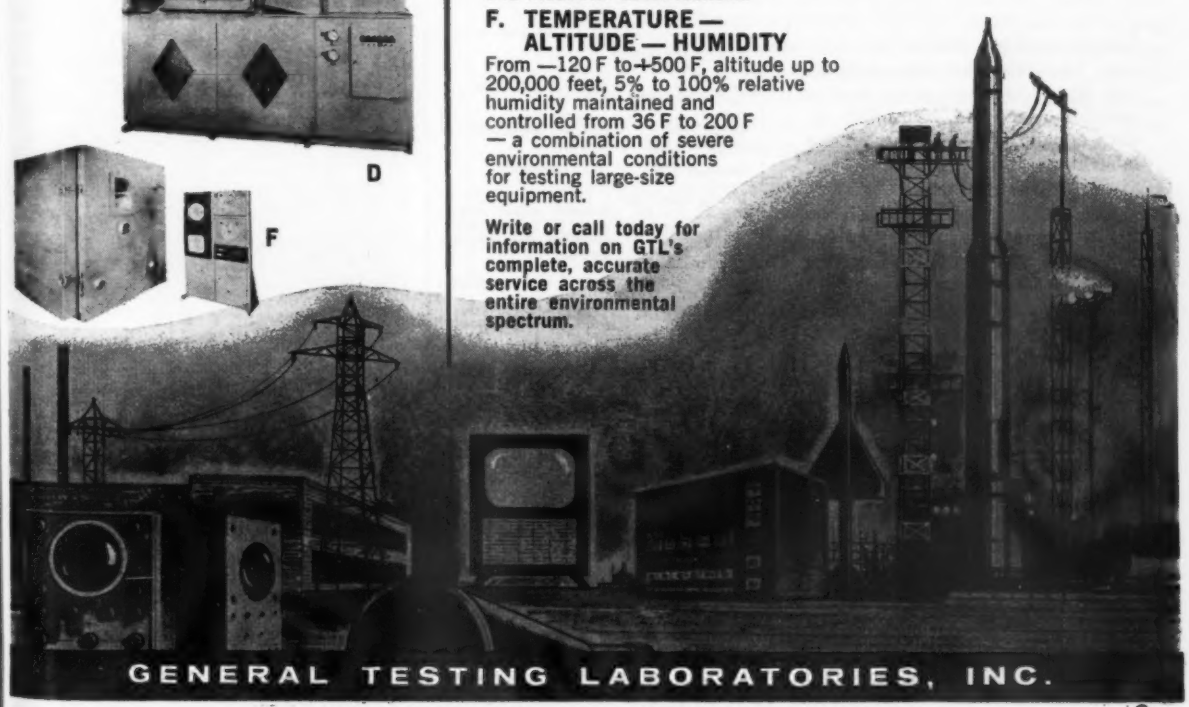
C. RAIN & SUNSHINE
Test chambers and instrumentation meet latest military and industrial requirements for testing across the entire infra-red, visible and ultra-violet spectrums, and rainfall simulation from drizzle to downpour.

D. SAND AND DUST
Specially constructed equipment produces sand and dust environments with velocities up to 2300 feet per minute at temperatures up to 160 F, with required relative humidity maintained.

E. EXPLOSION
Tests performed in one of the largest chambers available, at simulated altitudes required by military and industrial specifications.

F. TEMPERATURE — ALTITUDE — HUMIDITY
From —120 F to +500 F, altitude up to 200,000 feet, 5% to 100% relative humidity maintained and controlled from 36 F to 200 F — a combination of severe environmental conditions for testing large-size equipment.

Write or call today for information on GTL's complete, accurate service across the entire environmental spectrum.



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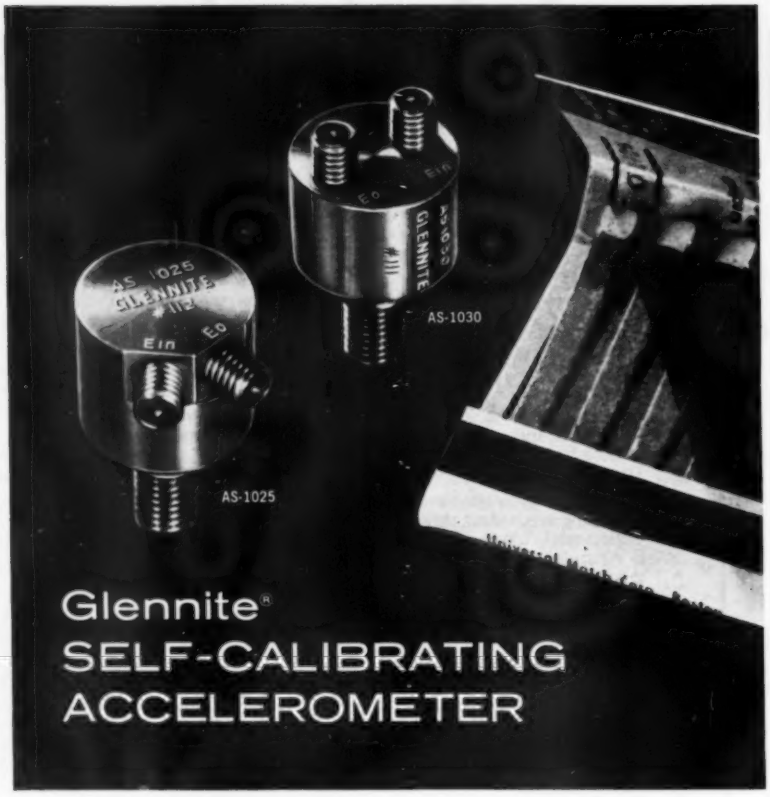


. . . for pre-flight and in flight calibration

Incorporating a dual seismic system, Gulton's new self-calibrating accelerometer now makes possible increased reliability in data acquisition—not only in the laboratory, but during missile or aircraft flight as well.

The instrument contains two transducers, a sensing element and a driving element. A square wave oscillator, weighing less than five ounces, is available to check accelerometer at pre-flight and in-flight stages. At other times, a small portable oscillator can be used eliminating need for bulky vibrating equipment.

Since both elements can be used as sensors, the accelerometer can be used as a dual output device—thus extending the capabilities of the instrument. For complete details and specifications write:

SPECIFICATIONS	
Sensitivity (with 4 ft. cable)	7.5 mv/g (minimum)
Capacitance (with 4 ft. cable)	1000 uuf (minimum)
Resonant Freq.	15 kc (minimum)
Driving Sensitivity	1 volt drive induces a minimum output equivalent to 1.0g acceleration on the seismic system
Weight	AS-1025, side-connected: 21 grams AS-1030, top-connected: 16 grams

GULTON INSTRUMENTATION DIVISION

Gulton Industries, Inc.

Metuchen, New Jersey

In Canada: Titania Electric Corp. of Canada, Ltd., Gananoque, Ont.

News Briefs

WASHINGTON—NASA has picked Avco Corp., Wilmington, Del., and General Electric Co., Evandale, Ohio, for engineering and preliminary development studies on a plasmajet rocket engine. A total of $500,000 is involved. The contract awards are seen as a first step toward a power plant that may carry man to the planets and back.

• • •

CLEVELAND—For every dollar spent on buying existing types of military equipment, 40 cents is spent in developing and testing new types, Dr. Herbert York, director of research and engineering for the Defense Department, said in the 84th commencement address of Case Institute of Technology.

• • •

SAN FRANCISCO—In the fiscal year ended June 30, the Air Force completed negotiations with Lockheed Aircraft Corp. for three military satellite contracts totalling $273 million. They are the Midas, Samos and Discoverer.

• • •

WASHINGTON—A non-profit agency, Aerospace Corp., has replaced Space Technology Laboratories, Inc., as a technical arm of the Air Force's Ballistic Missile division. STL, a subsidiary of the Thompson Ramo Wooldridge Corp., is expected to retain some major projects, however.

• • •

LOS ANGELES—The United States, according to Maj. Gen. Don R. Ostrander, NASA's director of launch vehicle programs, expects to send 75 to 105 major missiles heavenward in the next three years, thereby overtaking Russia in the space race. The general, addressing the semi-annual convention of the American Rocket Society, added: "We are now off and running."

• • •

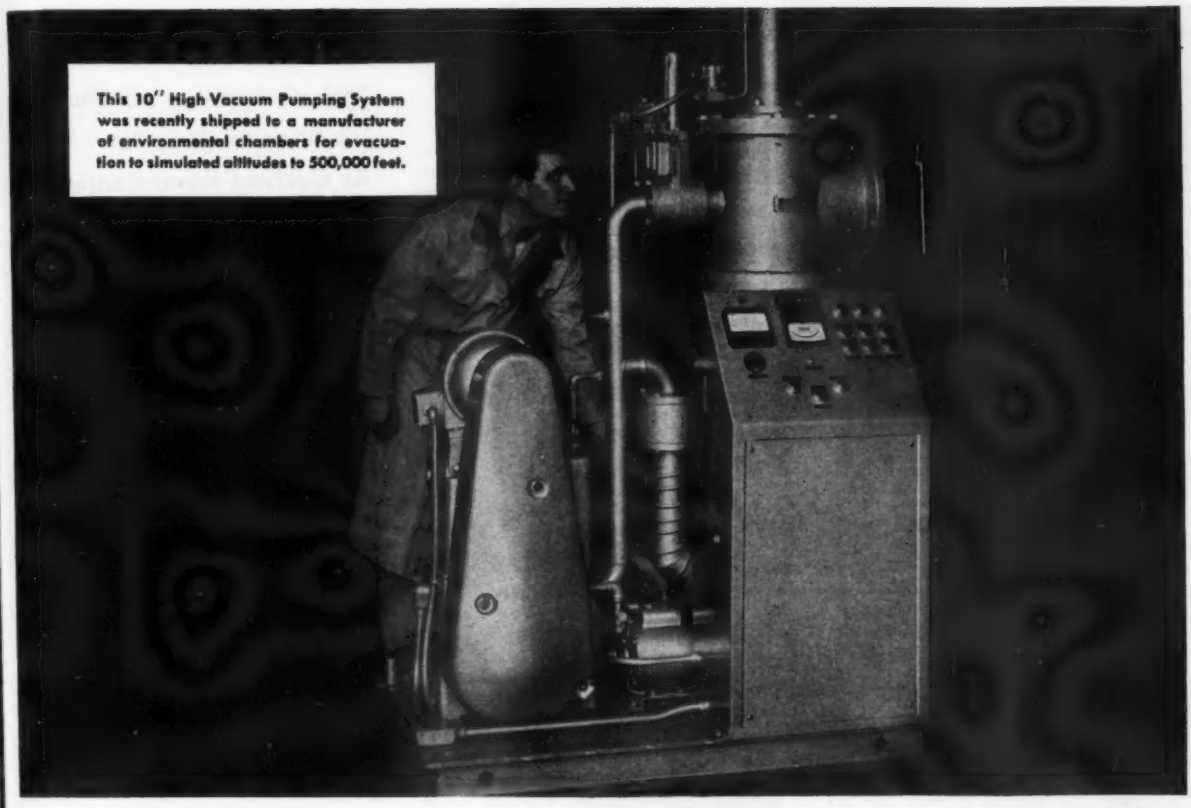
WASHINGTON—Lieut. Gen. Emerson C. Itschner, chief of Army Engineers, told the House Space Committee that the engineers plan to establish an exploration base on the moon in a decade. He said several concepts for a base are being studied.

• • •

WASHINGTON—NASA has announced plans for new facilities to simulate outer space and atmospheric reentry at the $18-million Goddard Space Flight Center under construction at Greenbelt, Md. Propulsion Test Facilities division of MB Electronics, New Haven, has been awarded a $400,000 contract to design the simulation facilities.

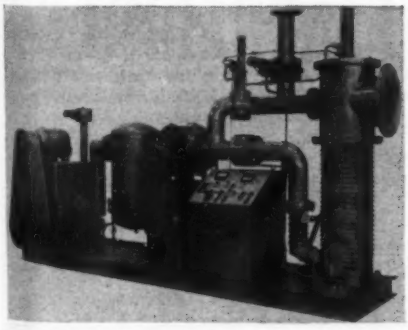
Space Division at Guardite

Guardite Company division of American-Marietta Co., Wheeling, Ill., has set up a Space Technology division, under the direction of Dr. Karl H. Seelandt, for R&D into hyper-environment and lunar-space simulation.



This 10″ High Vacuum Pumping System was recently shipped to a manufacturer of environmental chambers for evacuation to simulated altitudes to 500,000 feet.

SAVE DESIGN MANPOWER AND CUT COSTS WITH STOKES HIGH VACUUM PUMPING SYSTEMS



Designed to evacuate an aerodynamic wind tunnel facility, this specially designed unit features 3 stages: mechanical pump, Roots type blower and 16″ diffusion pump. System is base plate mounted and includes a graphic control panel. The unit is one example of Stokes ability to meet out-of-the-ordinary system requirements.

Now, your valuable engineering time can be saved for direction to other phases of your project. Stokes solves the vacuum portion of your problem with completely packaged pumping systems. Whether your test needs are 150,000 feet or 1,500,000 feet of simulated altitude, and test volume requirements are 10 cu. ft. or 10,000 cu. ft., Stokes has the system to do an effective and efficient pumping job.

Stokes oil booster type and diffusion type systems are designed to meet your needs for *compactness*, *reliability* and *efficiency*. The 10″ diffusion system in the illustration above, for example, requires only 20 square feet of floor space. Engineered around Stokes proven vacuum components, all systems include base plate, interconnecting piping, point-to-point wiring as well as the control console.

Stokes provides you with all the extras, too: push buttons, pilot light, contactors, starters and gaging. In addition, your installation costs and start-up time are reduced since field assembly is limited to one vacuum connection and three utility connections.

Why not let our Advisory Service study your particular requirements and make system recommendations. Today, while it's fresh in your mind, write to Stokes for complete information.

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Vacuum Equipment Division

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AROUND THE ENVIRONS...

IES Names Vandal President, Billet as Executive VP; Full-Time Office Opened

The Institute of Environmental Sciences has elected William L. Vandal as its second president, to succeed Harold C. Jones. Arthur B. Billet is the society's new executive vice president—putting him in line for next year's presidency if custom holds, and Henry F. Sander is executive secretary for a second year. After only one year of merged existence, the IES decided to make the executive secretaryship a full-time post.

Vandal

At the annual convention in Los Angeles last April, a year after it was formed through the merger of the Institute of Environmental Engineers and the Society of Environmental Engineers, the IES also named these other officers:

Billet

Raymond Yaeger, fiscal vice president, succeeding Billet in that position; Russell Lowe, vice president, publications, succeeding Yaeger; Leon D. Carver, former president of the SEE, vice president, membership, succeeding Lowe, and John J. Regazzi, vice president, local chapters, succeeding Carver.

Regazzi, who is with Arma, on Long Island, is the only new face on the IES' panel of officers but is no newcomer to environmental affairs. He was very active in the old IEE and in the New York chapter.

Vandal last Fall moved over from Autonetics, where he was engineering group leader in the environmental laboratory, to Aeronutronics, a division of the Ford Motor Co., Newport Beach, Calif., where he is manager of the environmental lab. He was a founding member of both the IEE and SEE.

Sander

'61 Meeting in Washington

Billet, former IEE vice president, is with Vickers Incorporated, in Detroit. An old hand at running environmental conventions, Billet will be general chairman of the 1961 meeting, to be held at the Sheraton Park Hotel, Washington, D. C., April 5 to 7.

Jones

Yaeger is with Chrysler's missile division in Warren, Mich. Lowe recently went to Burbank, Calif., as manager of Barry Controls Incorporated's Western division. Carver is with High Accuracy Products Corp. Sander had been with Vapor Heating Corp. His address is P. O. Box 191, Mt. Prospect, Ill.

The IES national board will meet again next Aug. 5 in Chicago. The meeting after that will be on Nov. 18, in Oakland, Calif.

Shaidnagle Elected Head Of Los Angeles Chapter

Robert H. Shaidnagle, of Ling-Altec Electronics, Inc.'s, sales and marketing staff, has been elected president of the Los Angeles chapter of the Institute of Environmental Sciences. He succeeds Jerome Bakalish.

Shaidnagle

An electronic engineering graduate of the U. S. Naval Academy in 1953, Shaidnagle joined Ling-Altec a year ago. He lives in South Pasadena, Calif.

He was chairman of the outside programs committee for the IES national meeting last April and has been a member of the Institute's vibration and acoustic subcommittees.

29th Symposium on Shock, Vibration to Open Nov. 15 At Oakland Naval Center

The Defense Department's 29th Symposium on Shock, Vibration and Associated Environments is scheduled for Nov. 15 at the Naval Supply Center in Oakland, Calif. The sessions, which require secret clearance for attendance, are designed to help the government and its contractors collect and exchange data.

Parallel sessions will be held on two general subjects. Following are topics selected for planning purposes:

Environments and Environmental Testing—Shipping and transportation environments; results of full-scale tests on shipboard weapons systems; full-scale versus model testing; missile flights environment data; extrapolation or prediction of environments and their effects; relationship between simulated and actual environments; design of environmental tests to predict actual life; matching factory to target environments with functional design factors; testing—a research tool or a requirement in a specification, and relationship of environmental testing and reliability.

Protective Construction

Environmental Problems in Protective Construction—Ground shock environments with particular attention to high overpressure regions; soil and structure interaction in protective design; problems involved in superhard or nearly invulnerable installations; transmissibility of shock hardened structures; shock mounting and isolation for ground support equipment in hardened installations; earthquake effects and their relationship to blast shock problems, and techniques for simulating ground shock from nuclear weapons.

Dr. W. W. Mutch, head, R&D centralizing activity for shock, vibration and associated environments in the office of the director of defense research and engineering, has asked those who would like to submit papers to contact him as soon as possible.

Educational Environment

IES Group, Ling, MB Sponsor Courses

A 12-week lecture series on environmental testing, sponsored by the Boston Area chapter of the IES at Northeastern University, ended June 28. More than 230 persons who attended received certificates at a banquet.

The series was organized by Gerhard Doerring, president, and Peter Fowler, program chairman, of the Boston chapter, in cooperation with university officials. A similar lecture series is planned for next year.

The third of a recurring series of courses on vibration testing will be given Aug. 8-19 by Ling Electronics at its Anaheim, Calif., plant. The course will cover sine, complex and random wave vibration, with John C. Jordan, Ling research engineer and a graduate of Georgia Institute of Technology, as moderator.

The Ling course will be repeated in mid-September. Information may be ob-

tained from "Study in Vibrations Registrar," Ling Electronics Division, 1515 South Manchester Ave., Anaheim, Calif.

MB Electronics is sponsoring several seminars and short courses. At its New Haven plant, it is continuing its seminars on complex vibration, with additional Summer sessions scheduled for Aug. 2-11 and Sept. 13-22. A training series for operators and equipment maintenance personnel will continue at the plant Aug. 16-25, Oct. 18-27 and Jan. 17-26, 1961.

Wayne Tustin, MB Electronics, P. O. Box 1825, New Haven 8, Conn., is the person to contact for additional information.

In cooperation with MB, the University of Southern California is planning a short course on theory and practice of vibration testing for Thursday nights of the Fall semester. Details are being handled by Dennis C. Lynch, MB Electronics, 10816 Washington Blvd., Culver City, Calif.

Two seminars in fixture design were held at Brooklyn Polytechnic Institute last month in conjunction with MB.

ENVIRONMENTAL MISCELLANY

Office changes: CONSOLIDATED VACUUM CORPORATION, Rochester, N. Y., has opened a district sales and service office for the Washington, D. C., area with Lionel B. Buraks in charge. Located in Alexandria, Va., the office reports to CVC's Philadelphia sales office . . . The Levittown, Pa., district office of ENDEVCO CORPORATION, Pasadena, Calif., has been moved to 195 Nassau Street, Princeton, N. J., with Field Engineer Carl B. Salan in charge.

Sales policy: Greater emphasis on standard model environmental test equipment is part of the new sales program of MISSIMERS INCORPORATED, Glendale, Calif. Sales are handled nationally through reps.

Jobs done: THE RUCKER COMPANY, Oakland, Calif., has completed installation of its second large acceleration test machine at Lockheed Aircraft Corp., Sunnyvale, Calif. With a diameter of 23 feet, the machine can handle loads up to 6,000 lbs while simulating 150 g. Other recent Rucker installations of 20 to 70 feet: Martin-Denver, Redstone Arsenal, Douglas-Santa Monica, GE-Pittsfield, Thompson, Ramo-Wooldridge-Rocky Mount and Canadair-Montreal.

Organization: Propulsion Test Facilities, originally part of MB Electronics, has been set up as an independent operating division of the parent company, Textron Electronics, Inc.

Dividends: BARRY CONTROLS, INC., Watertown, Mass., is paying a quarterly cash dividend of 10 cents per share July 28 to holders of record June 24. It will be the third of the current fiscal year. The others: 10 cents per share in March and a one-for-six stock dividend in April . . . AIR REDUCTION CO., INC., New York, parent of Pure Carbonic Co., Inc., paid a regular 62½-cent quarterly dividend June 6, its 172nd regular quarterly dividend in a row.

Fiscal Highlights: Sales of TENNEY ENGINEERING, INC., Union, N. J., manufacturer of environmental test chambers, rose to $4,731,660 in 1959, compared to $4,501,735 the year before. In the first '60 quarter, the firm booked a record $1,100,000 in new business, compared with $400,000 for the year-earlier period, as a result of orders for a number of unique space simulating chambers. Saul S. Schiffman, chairman, and Monroe Seligman, president, said Tenney's 1959 net income after taxes of $67,069 reflected "very substantial costs of a R & D program and expansion of our refrigeration, heating and air conditioning products division." . . . AIR REDUCTION CO., INC., reported record sales of $200,603,636 for 1959 and an 11.2 per cent increase in net income, which reached $14,850,600. Per share earnings were $3.81 in 1959 and $3.47 in 1958. Sales and earnings for the first quarter of 1960 were even higher than 1959's, according to John A. Hill, president.

AVS Symposium Oct. 12-14

The seventh national symposium of the American Vacuum Society will be held Oct. 12-14 at the Cleveland-Sheraton Hotel, Cleveland. Those interested in submitting papers should contact C. R. Meissner, Georgia Institute of Technology, Engineering experiment Station, Atlanta.

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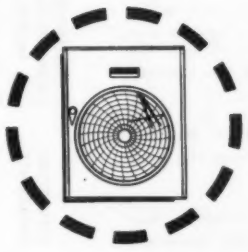

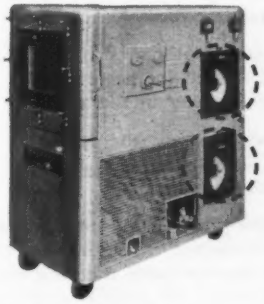

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Halting Resonance Tests at Failure

by **DONALD McCLUSKEY**
Senior Project Engineer
Unholtz-Dickie Corp.

A STANDARD ELECTRICAL FUSE is the basis of an easy, useful trick to shut down a fatigue test at the moment of fatigue failure. It can be used any time a sinusoidal fixed frequency test is run at the resonance frequency of the specimen, and with it the test may be relatively unattended.

The test must, however, be in a low frequency range, and exciting force must be obtained from an electrodynamic shaker attached to the point of high mobility.

Actual occurrence of failure in the specimen shuts down the shaker. By means of a timing clock or frequency counter, the exact number of cycles to failure can be reckoned.

The trick is to insert an external fuse of proper value into the driver coil or armature circuit of the shaker. Under proper conditions, when fatigue failure begins, current in the armature shaker begins rising from normal value. As the failure progresses, the current continues to increase until the fuse rating is exceeded. The fuse then blows and shuts down the shaker by opening the armature circuit.

Takes Only a Few Minutes

The simplicity of the trick is apparent. The whole operation, from determining the rating of a readily available fuse to inserting it takes but a few minutes.

To determine whether or not any particular test can be arranged to shut down in this manner, make the following quick check (which will also give the proper value of the fuse):

1. With the specimen connected, put the shaker system on manual operation.

2. Set the driving frequency to the resonance frequency given by the test specifications.

3. Set the sinusoidal power supply gain to obtain the vibration level desired in the test. Then note the current reading on the ammeter in the armature circuit.

4. Now slowly operate the frequency control so that the frequency shifts by 10 or 20 per cent, leaving the gain control untouched.

5. Observe the ammeter in the armature circuit as the frequency is changing. If the reading on the ammeter rises by 20 per cent or more, then the system can be fused to shut down.

The fuse size is chosen by picking a rating which is a little larger than the current noted in Step 3. When this fuse has been wired into place, the test is ready to go.

Why It Works

The trick works because of several phenomena.

First, when a fatigue failure occurs in a resonant specimen, at least one of several changes takes place. Usually the frequency of resonance becomes lower, due to a decrease in structural stiffness because of the progressive failure of a spring member. Conceivably the reverse could happen and resonant frequency could rise after a failure if an effective mass section became detached without affecting the stiffness of the structure.

Another possible change with failure is an increase of damping in the specimen. Usually this is because broken sections rub together, dissipating energy. Both an increase in damping and a shift of the resonance frequency have the effect of lowering the amount of mechanical buildup at the fixed test frequency.

Still another phenomenon is the coupling of conditions in the mechanical system to the electrical circuit of the shaker. When operating with a resonant mechanical load, an electrodynamic shaker appears as a high electrical impedance to the driving amplifier. Changes to this resonant system which tend to decrease the mechanical buildup are reflected as a lowered electrical impedance of the shaker. This decrease of electrical impedance permits more current to flow in the armature. The increase of current is utilized to blow the fuse.

Figues 1 and 2 show these interrelated phenomena for a typical case. For a test frequency of 20 cps, Fig. 1 shows the mechanical buildup, the armature impedance and the current, all before failure. Fig. 2 shows these after a fatigue failure has caused the resonance to drop to 15 cps.

Thus this shutdown method is sensitive to a change in a resonant condition, which in turn affects the electrical

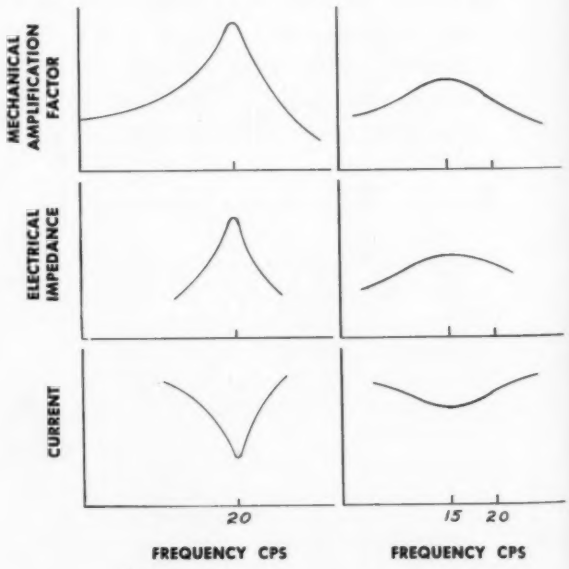

Figure 1
Conditions before Failure

Figure 2
Conditions after Failure

Here is a simple do-it-yourself method of stopping a single frequency fatigue test, run at resonant frequencies, at the moment of failure. Not the least of its advantages is saving expensive equipment from damage.

McCluskey

Donald McCluskey signs his article as senior project engineer, indicative of the technical side of his long workday. His other side and title of treasurer of Unholtz-Dickie Corp., Hamden (New Haven), Conn., bespeak his competence in the business world. Don is a Yale man, with a bachelor's degree in mechanical engineering and a master's in electrical engineering from that university. Before he joined the group of top engineers who organized Unholtz-Dickie a little more than a year ago, he was senior project engineer at MB Mfg. Co. He is the designer of Unholtz-Dickie's Model 100 and Model 200 shakers.

circuit, and causes the fuse to blow. By the same reasoning, the method will still work if other occurrences cause these same effects. An example is drift of the sinusoidal driving frequency away from the test resonant frequency, which might be caused by trouble in the oscillator or motor generator set. The same fuse will cause a shutdown, because the impedance will drop if the test frequency and resonant frequency become separated. If drifting of the test frequency cannot be tolerated, then this method can be used to stop the test if drift occurs.

Often there are other advantages to shutting down automatically at the time of failure. Besides learning the endurance limit of a spring element, it prevents the broken sections from further deterioration by additional cycles of vibration. Automatic shutdown aids in locating the area where the break actually started. This might not be possible if continual rubbing after a break changed the appearance of a broken surface.

With large specimens, continued vibrations after failure might damage a shaker. For example, after breaking loose, a member might be flailing about, striking the shaker.

A Specific Experience

A test in which the shut-down trick was used successfully involved dynamic endurance flexing of a rubber shear spring. The spring was subjected to one-inch peak to peak displacement at 20 cps. To utilize a small shaker with limited force output, a mass was added to the rubber spring. This put the resonant frequency of the combined system at the test frequency of 20 cps. The force requirement of the shaker was decreased due to the mechanical buildup of the resonant system. As a result, only a small value of current was required to drive the shaker.

Failure of the rubber spring dropped the natural frequency and the resulting rise in current blew the fuse.

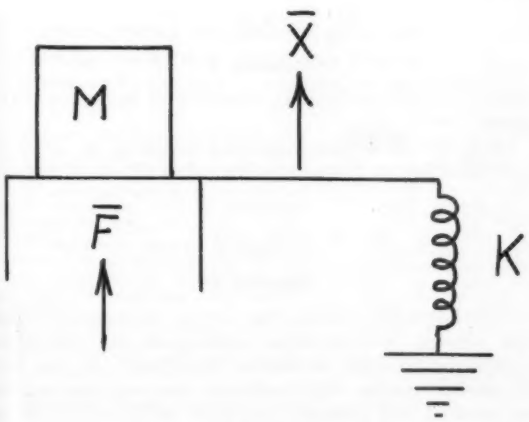

Figure 3

Early designs of this spring were eventually tearing after many cycles because of gradual deterioration of the rubber. Since cycles were being accumulated rather slowly at 20 cps, it was desirable to let the tests run overnight unattended. With the fused shutdown method it was possible to do this and still determine the time to failure.

Mathematical Basis

The mathematical basis for this shut-down method lies in the effect of the mechanical load on shaker electrical impedance. To keep the mathematics simple, the specimen is assumed to be a simple spring. One end of it is tied to ground, the other end has a mass driven by the shaker (Fig. 3), as described above. (Damping terms are omitted.)

It is convenient to lump the shaker mass with the specimen mass. Also, the specimen spring stiffness is lumped with the shaker table suspension stiffness. Then the complex number equation for this mechanical system is:

$$\bar{F} = -M\omega^2\bar{X} + K\bar{X}$$

Equation 1

The simplified formula for the electrical input impedance to the shaker is:

$$\bar{Z} = R + j\omega L + j\omega\left[\frac{U^2}{-M\omega^2 + K}\right]$$

Equation 2

where: M = lbs/in/sec²; R = armature resistance, ohms; L = armature inductance, henries; K = lbs/in; w (omega) = frequency of driving source, radians/sec; U = a constant for the particular shaker relating the mechanical units to electrical units. The parameter U can be found from the force per ampere rating of the shaker. If the force is in peak pounds, and amperes are rms values, then

$$U^2 = \left[\frac{\text{lbs. peak}}{\text{r.m.s. amp.}}\right]\left[\frac{1}{177}\right]$$

Note that Equation 2 contains the mechanical as well as the electrical terms. This equation, then, shows the effect of mechanical loads on the electrical impedance.

In particular, we have at mechanical resonance the

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familiar equation:

$$0 = -\omega^2 M + K$$

Equation 3

These terms appear in the impedance equation as follows (for resonance):

$$\bar{Z} = R + j\omega L + j\omega\left[\frac{U^2}{0}\right] \longrightarrow \infty$$

Equation 4

Thus, if damping terms are neglected, the impedance becomes infinitely large if the shaker is driving a resonant load. The presence of damping of course, lowers it to a high but finite value. This formula shows that as the mechanical resonance frequency varies from this driving frequency w (omega), the impedence decreases.

For current to increase as impedance decreases, there is another requirement. The source of sinusoidal electrical power must be a low impedance or constant voltage source. If this is so, the current will vary as the load impedance varies. Conversely, if the source were an infinite impedance or constant current source, there would be no variation in the shaker current regardless of what happened to the shaker impedance, and the fuse method would not work. Fortunately, most amplifiers and rotary supplies for shakers have sufficiently low internal impedance to be considered constant voltage sources.

Choice Of Driving Point

Further consideration of the method shows that in large structure testing, as for example, a missile frame or airplane wing, care must be taken in choosing the driving point of the shaker on the structure. By writing Equation 2 in the manner shown, it is equivalent to placing the attachment point at the anti-node (highest mobility), if the structure is a distributed spring mass system. The point of highest mobility would appear the same to the shaker as the lumped spring mass system. The fuse method can be made to work for this case.

The method must be limited to a frequency region where the mechanical velocity is large enough to have an appreciable effect on the electrical system. This is seen by examining Equation 2 and rewriting it to include the mechanical damping term:

$$\bar{Z} = R + j\omega L + j\omega\left[\frac{U^2}{-M\omega^2 + R_M j\omega + K}\right]$$

Equation 5

and expressing the damping in terms of the damping factor "zeta".

$$R_M = 2M\omega_n \zeta$$

Equation 6

where w_n is the mechanical resonance of the system to be tested.

Then, for the constant damping factor, as w_n occurs at higher and higher frequencies, Equation (5) at w_n becomes

$$\bar{Z} \approx j\omega_n L + \frac{U^2}{2M\omega_n \zeta} \longrightarrow j\omega_n L$$

Equation 7

Thus Equation 7 shows that if the frequency becomes high enough, the inductive portion of the impedance swamps the reflected mechanical impedance. In the average shaker system with ordinary damping factors, the fuse method will probably not work much above 200 or 300 cycles.

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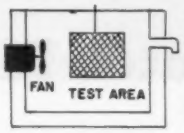

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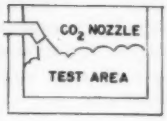
2 direct discharge of liquid CO_2



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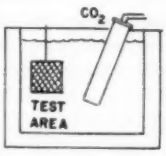

For low cost production-line cold testing. Crushed dry ice or bulk liquid CO_2 is injected into an acetone, methanol or trichlorethylene base solution. Items to be tested are immersed in the slurry which has a temperature of minus 109°F. An ideal method of making cold "shock" tests.

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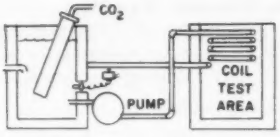

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Taking the Guesswork out of Environmental Testing

by HENRY K. GROWALD
Chief of Engineering Tests
Convair, Forth Worth Division

Flora and fauna adapt themselves to their surroundings—or environment. Thus animals grow longer furs in the winter, and trees shed their leaves. But the things man makes are not so adjustable. They must be built to survive their mechanical environment.

WHATEVER DIFFICULITIES MUST be overcome, the engineer has four relatively simple things to do when he sets out to design a piece of machinery. First he must determine what surroundings the machinery will have to work in—commonly contained in a specification. Second, he must design for the specified environment. If, for example, a part is to consist of two different metals, the different expansion and contraction characteristics of each under heat and cold must be taken into consideration.

Next, the part must be built. Process control and inspection assures that the part is built to the drawings. This is the time to resist substitutions of materials that may prove unwise, indeed.

Finally, the engineer must determine if the finished article will operate satisfactorily in the specified environment. This means that the engineer has to devise chambers and other simulating equipment.

The Cheapest Way Pays

Seek out the cheapest means of accomplishing this simulation. If a piece of pipe or an accumulator is to be taken to 40,000 feet, it may be more economical to test it with factory air, by adding the subtracted pressure at altitude to the pressure at the inside of the pipe, than to use an altitude chamber. The pipe doesn't know where it is, and for the purpose intended it is only the pressure difference between the inside and the outside that counts. However, if the concern is with an electrical phenomenon such as corona or arcing, rarified atmospheres are essential.

Environment can be divided into two classes: those that can be determined by human senses, and those that are not felt. In the first class are *thermal phenomena,* such as heat and cold; *mechanical phenomena,* such as pressure, thrust or impact; those in the *visible spectrum,* or light; those in the *audible spectrum,* or sound; *electrical phenomena,* such as are felt from reasonable voltage, and visible *fungus* growths. Non-felt environments include *magnetic fields, irradiation, X-rays, sub-audible and super-audible sound, infrared and ultraviolet rays* and *corrosive environments.*

While non-felt environments can be sensed only with the help of instruments, those that are felt must be controlled by instruments, since at best human beings can determine only qualitative, not quantitative, status of an environment. We can tell if something is hot or cold, but not the degrees F.

Know The Environment

A design should never be started unless there is a clear-cut understanding of the environment under which a device will have to work. An example might be the support of modules in complex electronics systems. Because of the electronic engineer's lack of understanding of an aircraft environment, such support often is insufficient.

A large rectangular module or circuit board may be supported on all four edges; nevertheless, a study of the vibratory environment may require damping at its center. The designer may take due notice of thermal expansion and contraction of materials but does not study sufficiently the temperature effects on lubricants in bearings.

Quite often semiconductors are used in electronic devices which permit tremendous speeds of operation, as in memory circuits. However, these devices are destroyed by irradiation, so the trade-off where radiation is present may be to go back to magnetic devices. When a designer

Early last year, Convair's Henry K. Growald delivered a speech on "Mechanical Environment" at a dinner meeting of the Southern Ohio chapter of the Institute of Environmental Sciences. It was a restatement of basic principles based on 33 years of experience. Recently, Environmental Quarterly asked him to review his remarks in the light of the swift rush of events since he spoke. Because principles do not change readily, there were no changes, and they are presented in the accompanying article pretty much as originally expressed. Here is an interesting fact about the author, who is a graduate of the technical university of Berlin-Charlottenburg: twenty-nine of his 33 years of engineering experience have been with Convair. His assignments have included design work, armament engineering, project engineer, experimental superintendent and engineering tests. Currently he is charged with directing engineering test laboratories and engineering flight test activities at Convair's Fort Worth division.

Growald

The delta-wing, Mach 2 B-58 "Hustler," with its detachable underbelly pod, has been a major program at Convair-Forth Worth. Test set-ups in accompanying illustrations are for this airplane.

uses brazed joints, he must be acquainted with the chemistry of the braze, because quite often moisture, particularly salt air, at the edge of the joints forms a galvanic battery with resultant progressive corrosive destruction.

In short, the environmental engineer must not be too proud to consult the chemist, metallurgist, or nuclear physicist.

Heat Transfer May Be Tricky

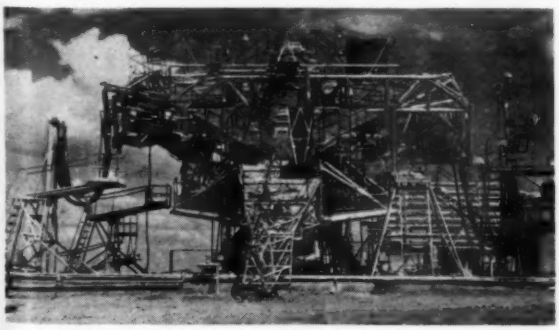
Heat transfer must be understood both qualitatively and quantitatively, particularly as regards length of exposure. An electronic device that works well for about an hour in a missile or a fighter-type airplane may become heat saturated in a 10-hour flight of a bomber. In other words, the fact that a device has worked well in some application of light intermittent duty does not necessarily mean that it will do the same for heavy long-period duty.

Possible combination of environments must be considered carefully. For instance, a mild form of corrosion may not affect the desired lifetime of a part. A mild form of vibration may also be harmless. But the combination of the two may undesirably shorten the lifetime of the article.

To make sure that a part will be tested under the environments for which it is designed, the original specification should always contain a chapter on tests. When a specification is being written it is wise to have the help of those who are to do the testing, because many a time they may not have the required environmental appliances or chambers. Many of these items are long-term procurement items and must be ordered as early as possible.

Invite The Designer

The designer or his representative should witness all tests at the critical stages and should have the right to stop the test when it becomes clear that a design improvement is indicated. If it is necessary to go "back to the old drawing board," there is no use spending testing money until the ailment is remedied.



Full-scale fuel system test, with altitude and operational fuel temperature environmental capabilities.

Instrumentation for environmental testing should have its transducers as close as possible to the object to be tested, since a temperature gauge in a corner of an altitude chamber may find an altogether different climate than in the middle. Many articles will stand a gradual increase of a level of temperature but will go to destruction under cycling from high to low temperatures or high to low pressures and back again.

There is no set pattern of testing. For example, a piece of electrical apparatus, after a functional check, may undergo the following 19 individual tests:

Power variations . . . combination of temperature and altitude . . . high temperature . . . low temperature . . . altitude . . . vibration . . . acceleration . . . structural strength . . . endurance . . . dielectric . . . leakage . . . mechanical shock . . . thermal shock . . . explosion . . . radio noise . . . humidity . . . fungus . . . salt spray . . . and sand and dust.

On The Other Hand . . .

A hydraulic device, however may require these 24 tests: proof pressure . . . external leakage . . . internal leakage . . . flow . . . heat rejection and torque . . . functional check . . . pressure drop . . . low temperature . . . high temperature . . . vibration . . . endurance . . . shuttling . . . altitude . . . aging . . . dielectric strength . . . explosion . . . mechanical strength . . . humidity . . . fungus . . . acceleration and response . . . sand and dust . . . salt spray . . . burst pressure . . . and corroision and expansion.

If a part that has been evaluated is changed, the change should be scrutinized closely as to whether it would have an affect on any one of the prior test series. If there is a suspected effect, the applicable portion of the test series should be rerun. Where complete retesting is required, its cost should be considered before putting the so-called production saving into effect.

Same Part — New Vendor — New Test

Another important point. If a new vendor is selected, the new part should be carefully scrutinized for differences that might require a new series of testing.

A word about endurance tests. While a pump may run fine for 50 hours, it may show signs of wear and tear after 500. This is called cyclic fatigue and during a cyclic fatigue test no adjustments or repairs should be permitted without their being translated into the handbook as part of the preventive maintenance. *Any strange phenomena observed should be reported to the design engineer and not kept a deep, dark secret,* even though this may appear to be extra-curricular.

Geometric relationship is too often neglected. If a valve is to be installed in the airplane in a vertical position, it should be tested in a vertical position. If a motor has a 27-foot lead, the lead on the test setup should be 27-feet long. In other words, do not favor the part during tests.

If a light-duty part is under test, and, say, it is to be

used twice in a 10-hour flight, it would appear that for a hundred-hour test period it should be cycled 20 times. However, possible maintenance operations prior to flight, such as inspections and checks, should be taken into consideration. It might very well be that the part should be cycled 60 times. If a part is supposed to be used during take-off and then shut off, what happens if, inadvertently, it is not turned off?

Early symptoms of a developing failure should be carefully observed and reported to the design or service engineer, since they may be of great value in trouble-shooting and preventive maintenance.

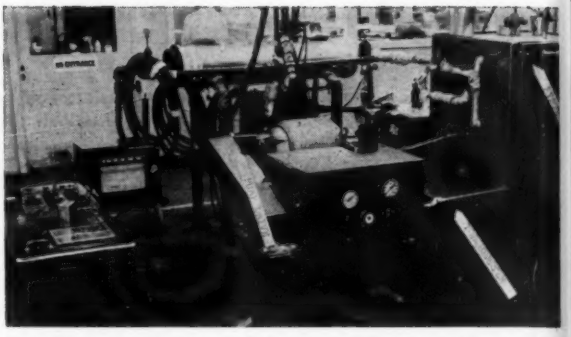
Right Instrumentation Is Vital

In environmental simulation, test chambers, sand blast machines, hot boxes and so forth, are taken for granted. But sufficient seriousness is not always given to instrumentation. It is vital that instrumentation be adequate.

Since many instruments read linear over a small range only, the instrument should be sought out that has the most linear characteristics within the spectrum to be tested.

Since instruments and particularly their pick-ups are subject to the same environment, the test instrument will often be influenced by this environment either temporarily or permanently. It is therefore mandatory that an instrument be calibrated before and after the test, and that it be calibrated prior to any new test whether it is suspect or not.

Does the speed of the test exceed the response, or lag,



High temperature hydraulic fluid test program, showing pumping efficiency test set-up.

of a given instrument? If it does, it is obvious that peaks may go unobserved or unrecorded, because the instrument never has time to get there. Then test money is being spent without getting valid quantitative test results.

A word in favor of recording instruments. Human powers of observation are poor under almost any circumstance, and if things happen fast or take tediously long, they are most unreliable. Besides, permanent records can be referred to again and again.

Some years ago a very large mass was being vibrated. The maximum double amplitude was one inch. The observing engineers and scientists were polled from time to time as to how much, in their opinion, this mass moved. The opinions varied from four to eight inches, when actually the double amplitude never exceeded one inch.

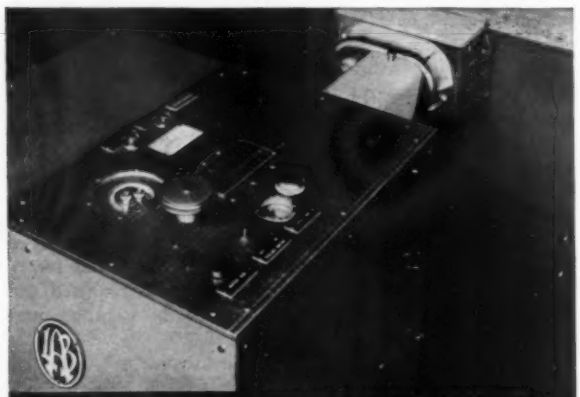
In Any Environment: Communicate

The test has been run. All precautions have been taken to assure valid and useful results—even to making sure that the part or apparatus tested is of exact production configuration (a two-edged sword, incidentally, because testing must be done in the early stages and the only thing available is a prototype model). The spectrum of the test has been that in which the test object is weakest, and many, many specimens have been subjected to it, to obtain a true picture of reliability. The results are entirely successful. What remains? Probably the most critical phase of the whole procedure: COMMUNICATION. The problem is to convey the results to the user of the test data without distorting the picture.

While tests often come off fast, reports take forever to get out and are usually bad literature. Vivid expression is required to hammer the facts into the mind of the man who reads the report. Reports need not be sensational or read like articles in a tabloid newspaper. But the salient facts which come out of the tests should not be hidden in a mass of neutral data.

Also, occasionally unexpected phenomena are observed but are played down in reports to the extent that their strident import is lost. Perhaps the best recipe is to precede each report with an abstract or digest of salient facts.

With the best testing and the best simulation of environment, the best that can be done is to take the gross errors out of design. The final verdict still comes from the consumer, based on use.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AEROTEST LABORATORIES, INC.

Comac Road, Deer Park, Long Island, New York

Environmental Quarterly's Album of People.

All branches of the environmental industry from every part of the country converged on the Biltmore Hotel, Los Angeles, last April for the annual IES meeting and trade show (See "Around the Environs"). Auto-Control Laboratories, L. A. B. Corporation and Don E. Hughes Co. shared a booth.

At the Barry Controls, Incorporated, exhibit, the Varipu'se 16750 a Barry's RIGIDAMP were explained to visitors by Carl Luce (left) a Ken Pratt (standing, right), both of the company's Glendale, Calif., offi Ling Electronics' offer (far left) of a free trip to Disneyland wa popular feature of the three-day meeting.

Robert J. Jacobson (left), president of Cincinnati Sub-Zero Products, and T. J. Frederick, his chief engineer (with catalogue) were on hand to welcome visitors. The compact and attractive design of the hi-low temp. cabinet at left, for electronic component testing, drew interest.

One of the portable Conrad, Inc ., chambers demonstrated rapid heat to +1,200° F. and cooling to —100°. At the booth were (l. to r.): E. Wright, manager of Conrad's Pasadena office; Henry T. Abstein a James L. Olmstead, both of Hughes Aircraft, and Dr. Carl T. Ash president of Conrad.

Conversation paused when the photographer approached the booth of Murphy & Miller, Inc., veteran producer of environmental test equipment and industrial refrigeration cabinets.

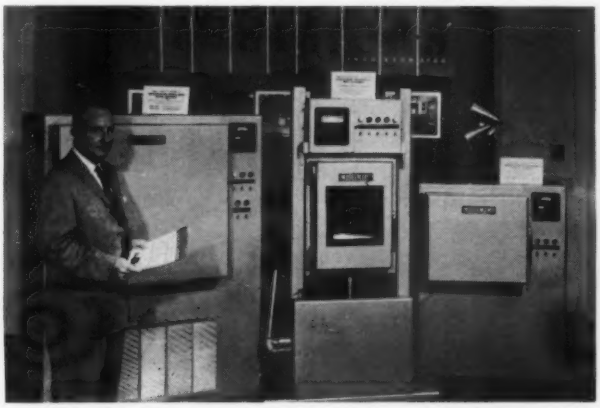
The advantages of carbon dioxide in gas, liquid and solid forms for temperature work were presentd to convention-goers by Pure Carbonic Co. division of Air Reduction Co., Inc.

Products, Places and Ideas... at the IES Show

Among many new products on display was Bemco, Inc.'s, 1½ cf. bench model salt spray chamber, shown to a prospect by Fritz Ehrler, of Bemco. Others present are Bemco's Stuart Giles (left) and Bal Huntley, and Dick Mayes (right), Bemco's El Paso area sales rep.

Attention was focused on Bill Cox, of Chadwick-Helmuth Co., as he controlled a shaker and SLIP-SYNC monitoring system to observe resonance modes on a vibrating specimen. The IES reported record attendance at both the technical sessions and the trade exhibits.

Guests at the Hudson Bay Co.-Erb & Gray Scientific Co. booth included Richard J. Mann, of the NAS' Prevention of Deterioration Center (center), and Virgil R. Sims, head of environmental testing at Emerson Electric Co. Steve J. Nagy, Hudson Bay's West coast representative, is their host.



Thomas W. Donohue, new director of marketing for Missimers Incorporated, displayed a chamber for thermal shock testing of semiconductors and two smaller temperature cabinets. Some 50 companies similarly displayed their wares at the show.

"The show was tops," commented Joe Davidson, president of Rototest Laboratories, Inc. At the Rototest booth were John Turnbull (left) and Ed Dargert (right), of Rototest, and Harry Biddle, of GE.

Tenney Engineering, Inc., rushed its 1,200° F., 500,000-foot simulator from the IRE show in New York to the IES show. Examining it (l. to r.) are: Fred Hermann, of Tenney; Dan Grady, GE; Robert H. Brown, Tenney, and David Askin, Frankford Arsenal.

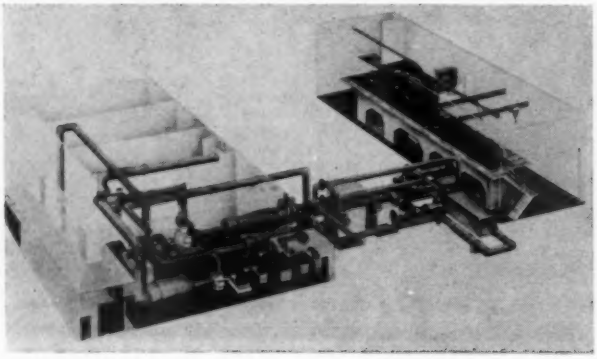
EQ's Album of the IES Show and Other Events of Note

The booth of Varian Associates, said to be the world's largest manufacturer of ion-getter type pumps for space chambers and environmental testing, was a stopping place for most show visitors.

Ling Electronics' S-14 servo system, which maintains a constant vibration level, was demonstrated by John C. Jordan. Ling also unveiled several high force shakers and a baby 25-pounder for the show.

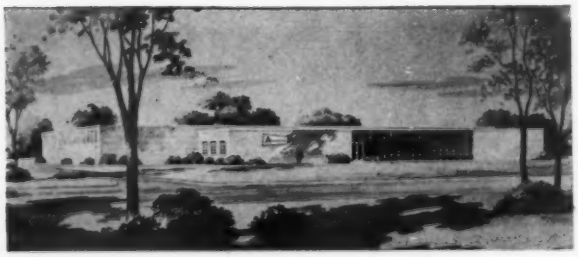
The big "A" of Associated Testing Laboratories, Inc. was featured by B. J. Wolfe Enterprises. Mrs. Jan Wolfe showed visitors ATL's all-lucite salt spr chamber, priced at only $1,075.

For More on the Show's Exhibits, Write "Show" and the Company's Name on EQ's Reader Service Card

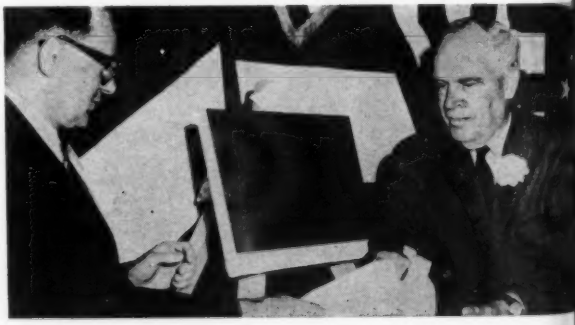


Aerotest Laboratories, Inc., has opened a new gas dynamics test lab at its big Deer Park, N. Y., facility. The lab is available on an exclusive facility rights priority basis for such programs as tests of turbo machinery and of power plants and for aerodynamics evaluations and model tests. (Circle EQ RSC "K.")

Typical of Gulton Industries, Inc.'s, recent exhibits is this booth featur Gulton's Glennite accelerometers. At the Los Angeles IES show, Gul unveiled a self-calibrating accelerometer, utilizing a dual seismic syst for combined environmental tests. (Circle EQ RSC "L.")



Associated Testing Laboratories, Inc., manufacturer of environmental test chambers as well as a test laboratory, moved into its new, 30,000-foot plant on Route 46, at Route 23, in Wayne, N. J., July 1.



With an assist from Saul S. Schiffman (left), chairman of Tenney En neering, Inc., Union, N. J., Gov. Luther H. Hodges, of North Caroli unveiled a dedication plaque at Tenney's new Wilmington, N. C. pl making refrigeration, heating and air conditioning products. (Circle RSC "M.")

People You Know...

CHANGING ENVIRONMENTS

Expansion Brings Lindley, Wheeler, Haggerty To Endevco

Peter L. Lindley has been named manager of technical services for Endevco Corporation, Pasadena, Calif., electronic instrumentation firm. He previously managed the special products section of Electro-Data Corp.

Two other staff appointments at Endevco are Howard C. Wheeler, supervisor, calibration and test department, and John Haggerty, special products engineer.

Wheeler was in charge of the environmental laboratory of the Naval Ordnance Test Station at Pasadena, Calif. for eight years. Haggerty was senior systems engineer with Hughes Aircraft on the B-70 and F-108 projects.

Lindley

Wheeler

Haggerty

Donohue

Flaherty

Perlstein

Patterson Heads Vacuum Products Division As Varian Group V.P.

Howard R. Patterson, formerly vice president of Varian Associates' Palo Alto tube division, has been promoted to the newly created post of group vice president for instruments and equipment, with responsibility for the instrument, radiation and vacuum products divisions.

Emmet G. Cameron, former executive vice president and general manager at Palo Alto, has been named group vice president in charge of all tube operations.

Ralph W. Kane, formerly vice president of the instrument division, has been named to the new post of vice president and manager of foreign operations, with responsibility for Varian's Zurich, Switzerland, and other overseas work.

Tenney Adds Flaherty, Perlstein In Engineering Staff Expansion

Edward J. Flaherty and Jerome Perlstein have joined the engineering staff of Tenney Engineering, Inc., Union, N. J., manufacturer of environmental test equipment.

Flaherty was formerly a consulting engineer with a number of leading firms involved in steam power, compressor installation and air and gas plant test facilities. Perlstein has spent several years in environmental simulation work, specializing in low temperatures.

Donohue Joins Missimers

Thomas W. Donohue has been appointed to the new post of director of marketing for Missimers Incorporated, of Glendale, Calif. Donohue was formerly sales manager for Statham Development Co. and had been chief engineer of the Mechanical Development division at General Mills.

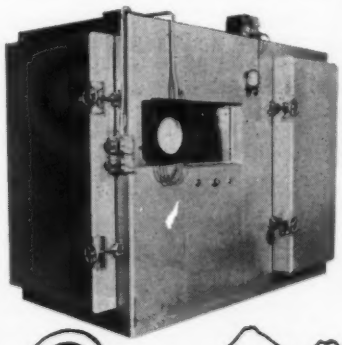
Gerb Named General Manager

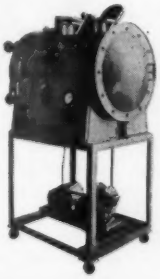
Irving Gerb has been named general manager of Aerotest Laboratories, well-known test center at Deer Park, N. Y.

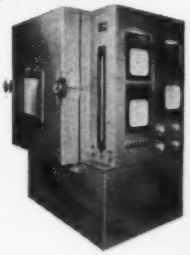
Environmental TEST CHAMBERS

Standard test chambers are expertly designed for accurate, reliable testing. Superior design and quality construction assure years of dependable service with a minimum of maintenance. Whatever the simulated condition desired, there is a Standard Cabinet designed specifically to do the job, guaranteed to give excellent performance.

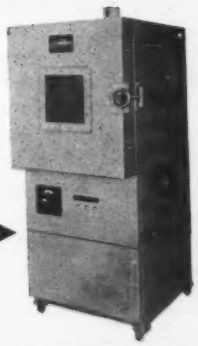
Standard Cabinet Company, a recognized pioneer in the field, has an uninterrupted history of over 18 years under the same ownership and management. It has acquired a wealth of experience and skill in the design and construction of chambers of every description.







ECONO-MODEL



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Sure you can land a fish with one hook, but chances are better with three . . .

That's the idea behind Roto-Test's Poly-vironmental* Testing.

By combining several environments in **one** single test you get more **factual** information.

For instance we recently combined high intensity acoustic vibration, high temperature and mechanical vibration into one fully instrumented chamber to test a component. These three tests, conducted at once, more accurately reflected the use conditions. The resultant data was a great deal more realistic, provided our customer with **more** factual information. Needless to say the customer is delighted.

Why not let us tell you about Roto-Test's Poly-vironmental* Testing . . . the combining of environmental tests to get more factual data under optimum use loads.

Complete facilities for: all standard military environments, plus high intensity sound, cine-radiography, random vibration, and others for electrical, electronic, electromechanical, and pneumatic components and sub-assemblies.

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Harrison

Badmaieff

Personnel Promotions Mark Growth Of Ling Divisions

The growth of various divisions of Ling-Altec Electronics, Inc., Anaheim, Calif., has resulted in a number of top-level management promotions.

At the Ling Electronics division, Robert F. Martin and Charles Theodore have been appointed vice presidents, respectively, of manufacturing and marketing. Edwin A. Andress is the new sales manager; Edward P. Klein is manager of systems engineering, and Paul S. Goodwin is chief engineer.

At Ling-Altec's Altec Lansing Corporation subsidiary, Alexis Badmaieff has been named chief engineer for acoustics-transducers and William H. Johnson, manager of engineering and technical information.

Ercell B. Harrison is now general manager of Altec Lansing's Peerless Electrical Products division, and James M. Farrell, formerly traffic manager of Altec Lansing, is Peerless' plant manager.

Promotions at Rucker

In a series of organizational changes stemming from an expansion program, Howard C. Zintz has been promoted from chief engineer to director of engineering of The Rucker Company, Oakland, Calif., manufacturer of fluid power systems and distributor of hydraulic and pneumatic components. His assistant, Albert B. Roth, succeeds him as chief engineer. Duane Shaw is the new assistant chief engineer. D. J. Bentley has been named plant manager at Oakland.

Webber

Johnson

Webber in Acton Sales Post

Donald W. Webber has been promoted to Western sales manager for Acton Laboratories, Inc., of Acton, Mass., with responsibility for sales of measurement and control instrumentation and components in the West Coast and Rockies areas. He was formerly sales engineer in the Los Angeles office.

H. MYRL STEARNS, president of VARIAN ASSOCIATES, Palo Alto, Calif., received an honorary doctor of science degree during special ceremonies at the University of Idaho's 65th commencement.

• • •

SY LICHTENBAUM has become sales engineer at GENERAL TESTING LABORATORIES, of Carlstadt, N.J.

• • •

BRUCE MINNERS, formerly test engineer at Hiller Aircraft, has joined LOCKHEED MISSILES AND SPACE DIVISION, Sunnyvale, Calif., as a research engineer.

• • •

DR. FRANK E. SWATEK, a West Coast authority on fungus, has been appointed to the new post of staff consultant at the laboratories division of AMERICAN ELECTRONICS, INC., Fullerton, Calif.

Kemly

Swatek

Hughes

Thompson

RICHARD J. KEMLY, a specialist in high altitude and combined environment studies, has joined the engineering sales staff of the UNITED STATES TESTING COMPANY, INC., Hoboken, N. J. **ERIC H. HALBERT,** a fluid systems expert, has joined the design engineering staff of the company.

• • •

ROBERT J. GARON, vice president of WYLE LABORATORIES, El Segundo, Calif., has been named general manager and will devote more time to recently acquired laboratories and diversification of the several Wyle corporations.

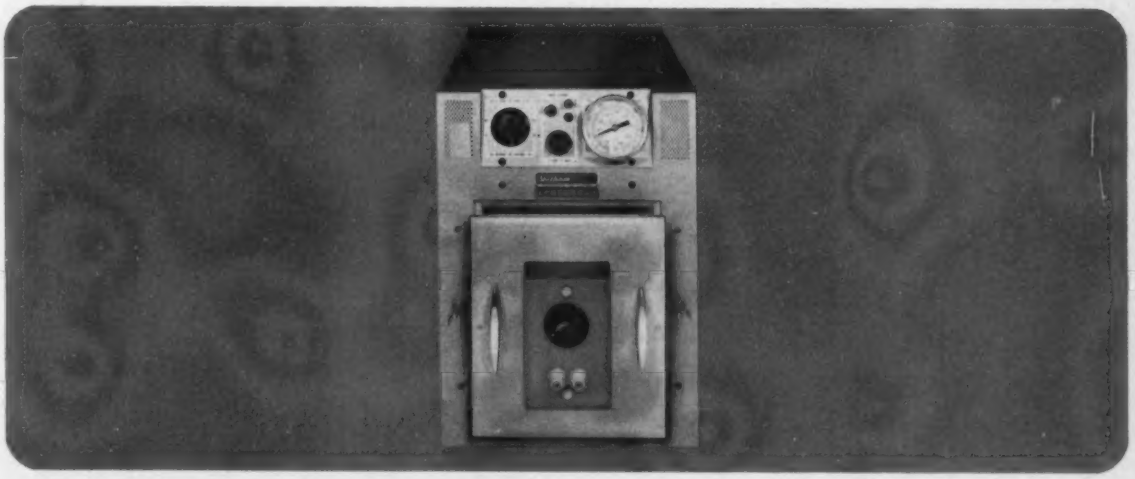
• • •

ALAN G. HUGHES and **MAX C. THOMPSON** have joined THE RUCKER COMPANY, Oakland, Calif., as inside sales engineers. Hughes will work at the Oakland headquarters, and Thompson at the Portland, Ore., branch office.

• • •

WILLIAM F. GEURDES, vibration project engineer at AEROTEST LABORATORIES, INC., Deer Park, N. Y., recently completed a comprehensive course in complex vibration practices at MB Electronics, New Haven.

component temperature testing



Statham / *"Test to be Sure"*

DEVELOPMENT CORPORATION

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fingertip quality control

Statham Development Corporation offers three new systems for component temperature testing. Providing utmost versatility and maximum reliability in minimal volume, these systems permit continuous testing across the critical temperature range from −55°C to +200°C.

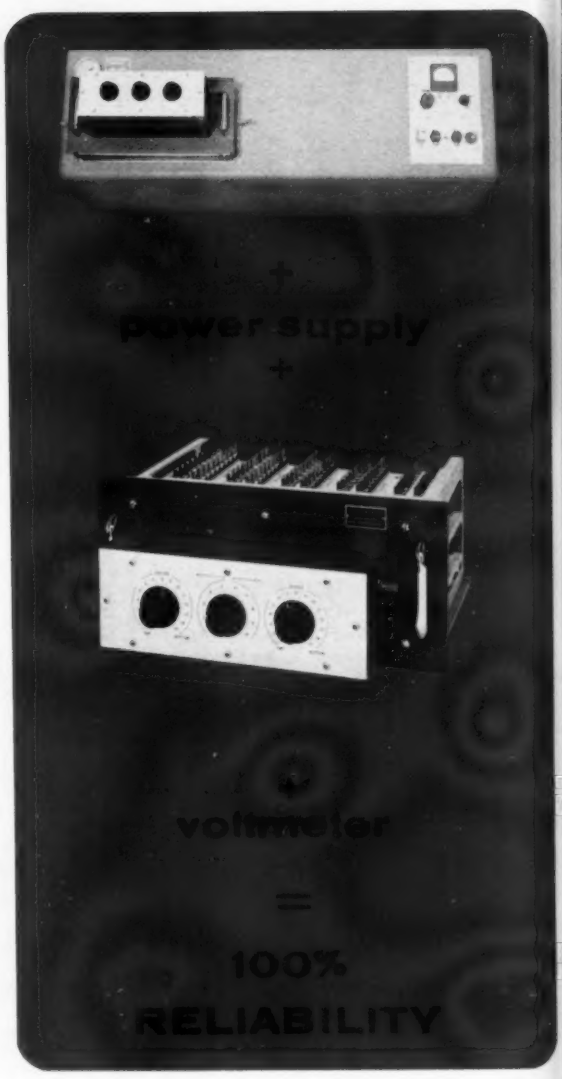
Greatly reducing problems of quality control, production, and laboratory testing, the new systems accept and test virtually any component: Capacitors, chokes, coils, condensers, connectors, diodes, insulators, rectifiers, relays, resistors, thermistors, transformers, and the like.

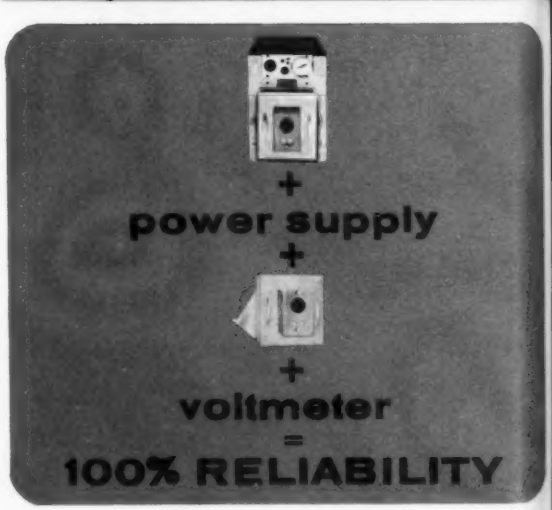
The standard system, essentially, consists of one of Statham Development's well-known test chambers, a power source, component test fixture, and a readout device. Statham also produces custom models to user specification.

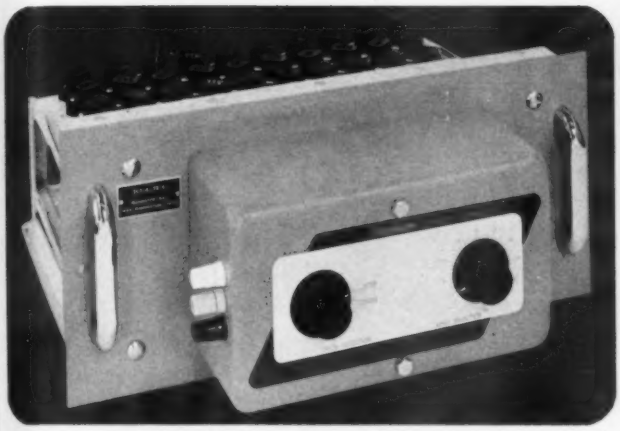
The test fixtures described herein — both the diode 2-lead and transistor 3 or 4-lead — are interchangeable within Statham Model TC test chambers. For economical testing of smaller numbers of components, the Model BC-RC, test chamber and associated test fixtures are recommended.

These new test systems offer multiple advantages: high capacity, quick loading, easy accessibility, interchangeable trays, individual-component selection, and high accuracy . . . make possible **fingertip quality control.**

For any environmental test problem you may have, look to Statham Development Corporation.





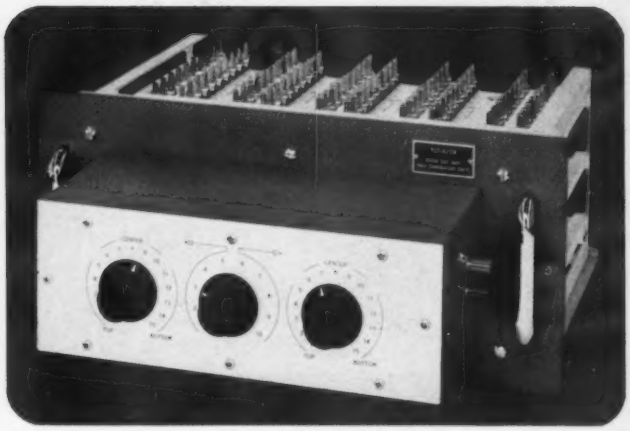


Transistor Test Fixture

3-4 lead components

The Statham Transistor Test Fixture, for 3 or 4-lead components, is designed to test rapidly the function of those components under varying temperature conditions. Creating thermal shock across the temperature range from −55°C to +200°C to a maximum of 100 components at one loading, the unit provides a rapid rate of hundreds of tests per hour.

Two removable shelves are a design feature that permits component loading even while the testing cycle is in operation. The Transistor Test Fixture is interchangeable within the Statham Temperature Test Chamber Types TC-2, TC-4, TC-5, and TC-15; this interchangeability results in more economical operation, both initially and in any subsequent expenditures. The test fixture will also accept 2-lead components. One assembly can accommodate many types of shelving fixtures for various sized components.



Diode Test Fixture

2 lead components

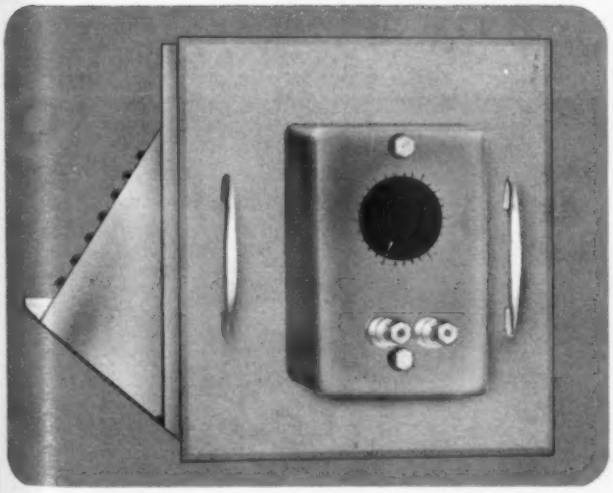
The Statham Diode Test Fixture, for 2-lead components, is designed for rapid, environmental temperature testing in the range from −55°C to +200°C. This test fixture, with a 3-shelf, 150-component capacity, permits up to hundreds of individual component tests per hour.

As with the companion transistor test fixture, the diode shelves are removable and allow component loading while the testing cycle is operating. Available to accept various lead lengths and shapes and with selective individual switching, the assembly is interchangeable within the Statham Temperature Test Chamber Types TC-2, TC-4, TC-5, and TC-15. Other features: rugged design, low leakage, test-reading accuracy, and extremely low temperature gradient.

S P E C I F I C A T I O N S

Capacity:	100 components — (50 per shelf)
Temperature range:	−55°C to +200°C
Maximum voltage:	1000 VDC or 700 VAC
Maximum current:	5 amp dc noninductive or 5 amps ac RMS.
Leakage:	1.0×10^{-9} amp at 500 v
Dimensions, inches:	8 x 17 x 7⅜ (in chamber)
Weight:	20 lb.
Construction:	aluminum frame trays, glass silicon shelving. Loranger sockets. Teflon wiring.
Circuitry:	One connector common with two connectors individually wired on standard shelving. Special circuits made to order.

Capacity:	150 components — (50 per shelf)
Temperature range:	−55°C to +200°C
Maximum voltage:	1000 VDC or 700 VAC
Maximum current:	5 amp dc noninductive or 5 amp ac rms
Leakage:	1.0×10^{-9} amp at 500 v
Dimensions, inches:	8 x 17 x 7⅜ (in chamber)
Weight:	26 lb.
Construction:	aluminum tray — shelf glass silicon Teflon wiring.



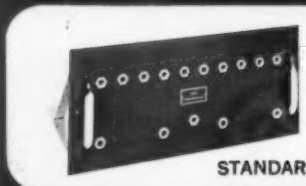
SMALLER TEST FIXTURES

The Statham Test Fixtures Types BCT and RCT are for rapid temperature testing of 2-lead (-2/CR) or 3 and 4-lead (-2/TR) components. These units are smaller than those described above, accepting a maximum of 30 components. Designed to fit Statham Temperature Test Chambers Types BC and RC, the fixtures have virtually all the advantages of the larger units: rugged design, high accuracy, and low leakage.

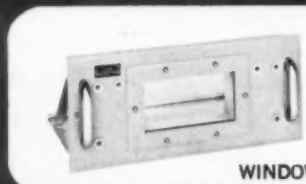
S P E C I F I C A T I O N S

Capacity:	30 components
Temperature range:	−70°C to +250°C
Maximum voltage:	1000 VAC
Maximum current:	5 amps
Leakage:	5 MuA @ 1000 v @ ambient 10 MuA @ 200 v @ 250°C
Dimensions, inches:	7¾" x 7¾" x 9¼"
Weight:	15 lb.
Construction:	aluminum trays, non removable shelf, with hard wiring.

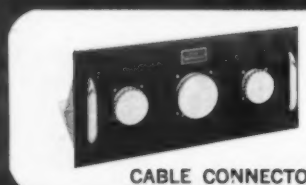
STOCK TEST TRAYS



STANDARD TEST TRAYS



WINDOW TEST TRAYS



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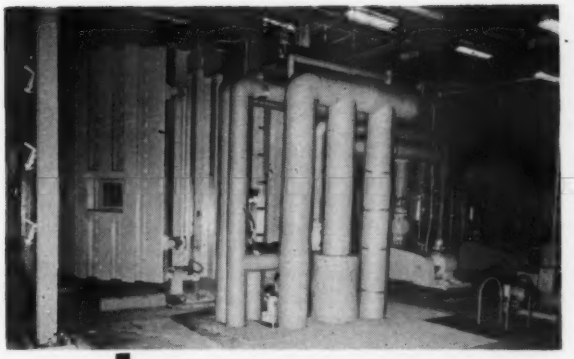


Strat chamber at Holloman AFB's missile development center has 8 x 8 x 11 feet clear work space and incorporates altitude, temperature, humidity, vibration and infrared.

Dependability . . . for Decades

by A. H. ABERNATHY, JR.
Chief, Stratosphere Chamber Branch
AFMDC, Holloman Air Force Base

Future needs for larger, more versatile environmental chambers are limitless, says this Air Force expert. Like a good house, a properly planned chamber will be in service 25 years hence on projects still to be dreamed of.

MAXIMUM DEPENDABILITY is a "must" in the concept, design, manufacture, storage, transportation and use of missiles. Critical in the over-all effort on missiles and their components are the environmental test facilities which measure the degree of dependability achieved.

Why environmental chambers? Actual missile flight is not always a satisfactory means of obtaining experience and successful recovery of missiles for analysis is difficult, to say the least. Picture momentarily the recovery of artillery shells—recovering missiles is much more difficult.

Missiles are intricate devices, requiring extensive statistical study of their dependability. A small electromechanical malfunction can be disastrous and cannot be corrected in flight because a missile is uninhabited and reaches the point of no return immediately after launching. This presents an economic problem which dictates elimination of malfunctions as much as possible by laboratory prooftesting prior to launching.

Small Chambers Predominate

Many environmental resistance tests are conducted in laboratory flight simulators, and environmental chambers are one of the most important of such simulation devices. Probably 95 per cent of the environmental chambers presently in use are small temperature and altitude units. The demand for larger chambers has increased greatly since the advent of the space age in 1957, and a few walk-in types with high altitude capability, such as the stratosphere chamber at ARDC's Air Force Missile Development Center (AFMDC), have become available recently. Only a very few large walkin facilities are now incorporating vibration exciters to give combined environment testing capability and, whereas, until about three years ago, few chambers had the ability or reason to exceed an altitude of 100,000 feet, today the demand is for 200,000 and 500,000 feet.

There appears to be no limit to future needs for large and versatile combined environmental test chambers. By 'large' is meant the walk-in type and greater. How large should we go? Any chamber which is built with internal dimensions of less than 100 feet will be too small for future demands. But, there are certain problems that should be

A. H. Abernathy, Jr., has been instrumental in the design, building and operation of the important Air Force combined environmental test facility he heads at Holloman Air Force Base. He came to the Center five years ago, after doing similar work at the White Sands Missile Range. A World War II Air Force officer assigned to technical aeronautical and standardization programs, he is an active reservist, with the rank of lieutenant colonel. He is a 1940 Texas A&M graduate in mechanical engineering.

Abernathy

This article is reprinted, with permission, from "PDC Newsletter," in which it appeared as "Missile Testing and Environmental Chambers." The "Newsletter" is a quarterly publication of National Academy of Sciences-National Research Council's Prevention of Deterioration Center.

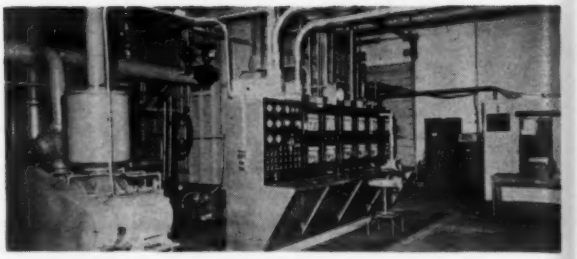
recognized in designing and constructing chambers. Versatility is essential. Special purpose chambers may become obsolete before they are completed. Estimates for completion times should be ultra-conservative. The specimen sometimes is obsolete before completion of a usable and satisfactory test facility.

Furthermore, quantities of chambers are needed because much test time is required for statistical studies on large missiles, major systems, and associated experimentation. If the chambers do not exist, or are not operating, the needed laboratory testing is neglected. Plans for these chambers should consider future general use and it must be realized that, like a good house, the chamber will be still in use perhaps 25 years hence, probably serving projects not now visualized.

How Much Testing?

Should the missile industry chamber-test components, subsystems, complete systems, or entire missiles? (By 'systems' is meant such items as hydraulic, servo-electric, guidance, and complete warhead systems, engines, inhabited space capsules, space suits, instrumentation packages, etc.) It appears that components need the most time in chambers, systems less, and entire missiles relatively less. Then, it follows that only a few, perhaps one, of the super chambers are needed, whereas approximately 20 times more of the smaller walk-in size chambers and about 1000 'dinky' test chambers for components are desirable.

How many simulated environments should be combined? If it were possible, zero gravity, altitude, temperature, solar and nuclear radiation, vibration, linear acceleration and deceleration should be contained in one facility. Of course, there are certain limitations placed upon us by basic physical laws. Zero gravity cannot be simulated. Linear acceleration can be obtained only in large installations such as track-sled devices. Constant-state accelerations can be obtained in centrifuges. But it is reasonable and practicable to combine altitude, temperature, humidity, vibration, solar radiation, and possibly constant-state acceleration into one package. Therefore, one very large, super installation should be planned for the not too distant future. An example of this type of foresight is the cold weather hangar at the Air Proving Ground Center, Eglin Air Force Base, Florida, another ARDC center.



Many variations of control, programming and physical set ups are possible in the AFMDC strat chamber, whose control panel is shown here.

Eye to the Future

AFMDC's large (8 x 8 x 11 feet clear work space) stratosphere chamber is an extremely versatile combined-environment simulation facility; its future application to missile testing will be extensive. The chamber's programming and rate of change abilities, together with the resourcefulness and ingenuity of test engineers, make it potentially valuable to any number of future projects.

This versatility has not been accidental nor without problems. It has taken more than four years to complete the facility to meet the original concept. Almost two years of planning preceded the start of construction. The chamber incorporates simulated environments of altitude, temperature, humidity, vibration, and infrared. Many variations of control, programming, and physical set ups are possible with this design. The original project for which the chamber was authorized has long since been concluded, but new and more important needs now exist, testifying to its long range usefulness.

Dependability then, important as it is at present, promises to remain critical if not to assume even a greater role. The essential test phase must be well planned to meet the missile requirements of the future.

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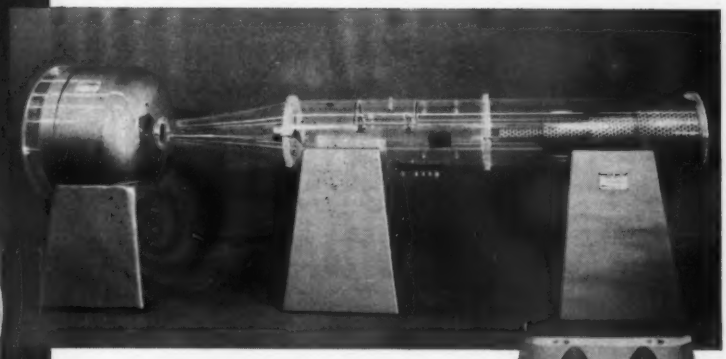

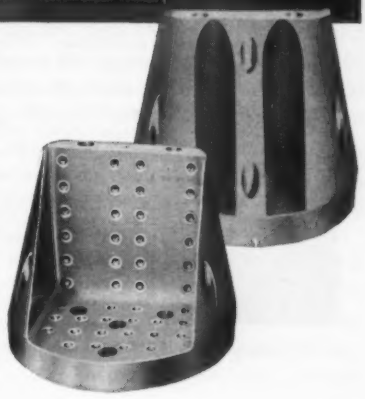

(left) **Shock Machine** SM-010, with shock pulses up to 1000 g's, meets rigid specifications of WS-107A-2 Environmental Test Requirements for ballistic missile components.

(above) **Acoustic Noise Generator** AG-012, producing up to 163 db of random noise, can be used singly or in systems with other speakers to meet specific testing requirements.

(right) **Environmental Test Fixture** (two views shown) is compact and versatile. Handles several specimens along three mutually perpendicular axes. Mounts on standard vibration exciters, centrifuges and shock machines.

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Avco test equipment meets severe environmental testing requirements of ballistic missile program

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- Provides sawtooth, quarter-sine, half-sine, square and triangular pulses
- Designed to permit easy duplication of particular shock pulse for repetitive testing
- Use-proven in qualification testing of electronic and electromechanical units for major missile program
- Occupies less than four square feet of floor space
- Incorporates operator safety features
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- Provides capability of recycling for life testing

ENVIRONMENTAL TEST FIXTURE. This new unit was designed for general environmental lab use and has several advantages over the conventional unit.

- Mounts on vibration exciters, acceleration and shock test machines
- Permits simultaneous testing of several small components in three planes
- Both fixtures available in beryllium to meet more stringent requirements
- Virtually resonance-free up to 2000 cycles
- Two sizes available: TF-006-1 (specimen size—6 x 6 x 4½ inches) handles specimens up to 6 pounds; TF-025-1 (specimen size—12 x 12 x 9½ inches) handles specimens up to 25 pounds

ACOUSTIC NOISE TESTING SYSTEMS. Avco has pioneered in the development of these systems, featuring the Avco Acoustic Noise Generator AG-012.

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- Single electrodynamic loudspeaker offers maintenance advantages over multispeaker systems
- Designed for operation with existing vibration amplifiers—no additional capital equipment required
- Single Avco Noise Generator permits tests formerly requiring up to 50 speakers
- Single Avco AG-012 becomes heart of complete noise testing system
- Designed for progressive wave and reverberant chamber testing
- Frequency range from 20 to 2400 cps

Avco's line of Environmental Test Equipment is fully represented by local agents throughout the continental United States and the world. For further information write: *Products and Services Department, Research and Advanced Development Division, Avco Corporation, Wilmington, Mass.*

Avco
Research & Advanced Development Division

by **Maxwell Lazarus**
Project Manager
Barry Controls Incorporated

Additional Considerations in . . .

Shock Testing Instrumentation

Maxwell Lazarus here concludes his two-part discussion of "Shock Testing Instrumentation." The first part, which appeared in the April issue of Environmental Quarterly, considered individual problems associated with recording transient pulse forms with various types of transducers. The effect of filtering was discussed at some length, dynamic accuracy of measured transients was examined, and transducer and filter response characteristics were illustrated graphically Copies of the complete article may be obtained by writing directly to Barry Controls Incorporated, 700 Pleasant Street, Watertown 72, Mass.

Lazarus

Total System Response

It is important that the concept of over-all frequency response be considered throughout an entire instrumentation system and not be restricted solely to the transducer. For example, although the AC amplifiers of most wide range oscilloscopes have sufficient low frequency response to assure good reproduction of most pulse forms, it is quite possible to encounter "undershoot" when pulses in the order of .060 to .100 seconds are being observed. The simplest solution to this problem is to utilize a DC scope input, but care must be exercised. Without proper scope adjustment, or "bucking," of any DC portion of the signal, if such exists superimposed on the transducer output, it is possible to lose the scope trace altogether.

The total system as previously noted must evidence a reasonable frequency response from transducer output to the final monitoring instrument, which could be an oscilloscope, tape recorder or oscillograph.

Figure 8 illustrates the frequency response of such a system utilizing a strain gauge accelerometer, low level preamplifier and voltmeter. This calibration was performed on an electrodynamic shaker with displacement monitored optically (a microscope) and also against a standard pick-up and output voltage recorded from a wide-band vacuum tube voltmeter. The low frequency fall-off depicted here is the result of the AC preamplifier response which is limited to about .2 cps at the 3 db point. This system is quite adequate for recording most half-sine pulse data; but for saw-tooth applications a system utilizing a good crystal accelerometer, matching cathode follower-amplifier and a broad frequency range recording instrument should be used (*Figure 10*).

The slight low frequency fall-off in this case reflects impedance matching between the crystal transducer and the cathode follower since the low level preamplifier was not used. This is representative of a good crystal transducer set-up, useful for reproducing the high frequency requirements associated with saw-tooth pulses while not sacrificing low frequencies. The 35 kc resonance shown would not affect the primary spectra and probably would have little influence upon the residual spectra, but if necessary a 10 kc low pass filter setting could be used to eliminate this problem.

Recording Instruments

The most common ultimate recording or monitoring instrument is, of course, the oscilloscope. Recording oscillographs also are often used for this purpose. Photoelectric instruments have galvanometers capable of recording up to 3 kc, but the majority of these galvanometer

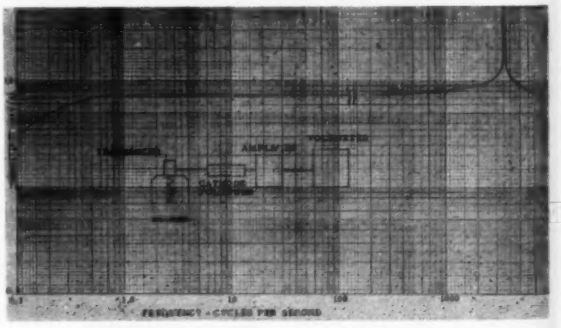
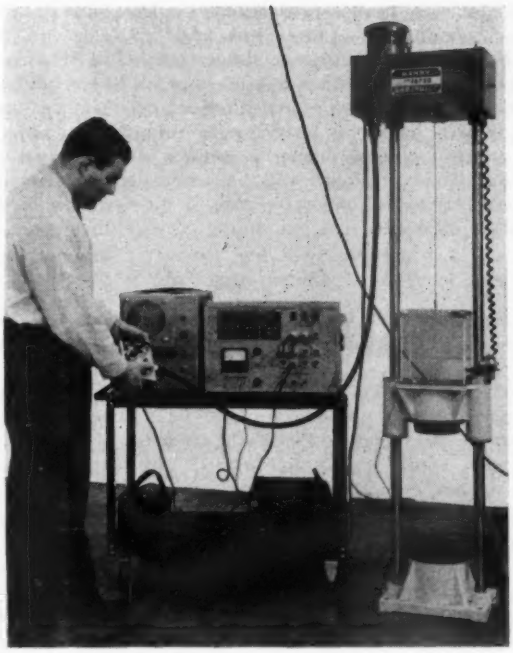


FIGURE 10
Frequency response curve for crystal accelerometer and cathode follower-amplifier with 10 feet of microdot cable.

units show a tendency to fall off between 1 and 3 kc. They should be carefully calibrated prior to use. Actually, for most practical shock measurement 3 kc is a reasonable limit since shock machine tables, if at all sizable, rarely evidence a first resonant frequency above 3 kc.

Direct writing oscillographs (stylus type) are unsuitable for most shock measurements because of limited transient response. Consideration should probably be given only to photoelectric oscillographs for this purpose if quick permanent records are desired.

Tape recorders are sometimes used for permanent data recording, and previous comments regarding system frequency response also hold true here. Low frequency dis-



Barry Controls Engineer Frank D'Blasi holds the control box of a Varipulse 16750 shock testing machine in front of an oscilloscope. Next to the scope is an Endevco Corp. amplifier and power supply, while an Endevco accelerometer rests on the 16750's test table. Behind the base of the machine is a photoelectric triggering device.

tortion is a problem in most tape records. Normally such units are not useful below 15-20 cycles per second unless frequency modulation is utilized. This type will record DC phenomena, and proper selection of the center carrier frequency will permit recording above 5 kc if required.

Calibration

Instrumentation calibration is another important aspect of shock testing. This is necessary before testing to determine the basic system sensitivity with which to establish the reference signals, and it is necessary during each test to reference the signal being monitored.

The most widely used technique is to excite the accelerometer with an electrodynamic shaker input, monitor the frequency and amplitude of excitation and record the output voltage of either the transducer or the total system. By calculating the acceleration input from the frequency and amplitude measurements in accordance with

$$G = \frac{(2\pi f)^2 A}{386}$$

where G=acceleration in G's, A=Displacement (single or double, corresponding with G) and f=frequency—cycles per second, and dividing the value of g into the corresponding voltage reading, a sensitivity factor in terms of volts/g can be determined. This factor then should be checked over the frequency range in question as well as through a reasonable dynamic range.

It is important that the units of acceleration be consistent with the units of displacement in the calculation noted above and that the voltage being recorded reflects

(*Continued on Page 34*)

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Shock Testing Instrumentation

(*Continued from Page 33*)

a certain known quantity so that a specific volts/g value can be expressed. For example,

Volts—RMS per g vector

Volts—peak to peak per g peak to peak.

Although this calibration technique is probably the simplest, a very definite high frequency limit is imposed by rapidly diminishing amplitude. With a microscope to record shaker table motion, calibration only up to several hundred cycles is possible.

Other Devices

Above this frequency other devices must be employed, since table motions are too small for practical resolution. The interferometer technique allows calibration up to 10 kc utilizing the known wave length of a monochromatic light to effect a displacement measurement. Other methods, such as the reciprocity technique and utilization of a laboratory standard accelerometer for comparison purposes, are also available. The latter is perhaps the most practical, provided that facilities exist to check the high frequency response of the standard transducer.

There is some question as to whether the sensitivity derived from the steady state excitation of an accelerometer is actually valid for transient conditions. Certain measurements and calibrations obtained in past years have indicated some discrepancies in this area. Therefore, at times the ballistic pendulum calibration has been used for obtaining accelerometer sensitivity data when transient shock conditions are to be measured.

Basically, the ballistic pendulum consists of two masses (usually equal for this purpose) suspended as pendulums. One mass is lifted to a predetermined height and allowed to impact through a linear spring into the second mass to which the accelerometer is secured. If the masses are equal, the second mass will be accelerated to a velocity equivalent to the impact velocity of the first mass, which can be expressed

$$V = \sqrt{2gh}$$

where h=vertical height from which the first mass was released. The first mass will stop perfectly at the moment of impact.

The acceleration time history or the velocity change imparted to the second unit will be a function of the mass of the pendulum and the stiffness of the spring through which impact was made. This expression can be written

$$t = \sqrt{\frac{W\tau^2}{g\,k}}$$

where t is the time duration of the resulting half-sine pulse. (Impacting this way through a linear spring will always produce a half-sine pulse.) Therefore, writing the equation of a half-sine pulse and solving for G, the peak magnitude of acceleration

$$G = \frac{\pi\sqrt{2\,gh}}{2t_o}$$

and the value can be related to drop height and spring stiffness.

Thus, a sensitivity factor in volts/g can be determined by dividing the peak output voltage into the calculated acceleration. This test will also indicate if any transient undershoot exists.

Calibration of Data

Actual calibration of data being monitored is accomplished by merely setting up reference voltage signals in the form of a sine or square wave and measuring time and magnitude against the wave-form being produced by the measurement system. This can be introduced through the total instrumentation system or it can be displayed directly at the final monitoring instrument, depending upon whether the accelerometer was calibrated independently or through the total system.

Another interesting method of displaying time when measurements are being made on an oscilloscope is to

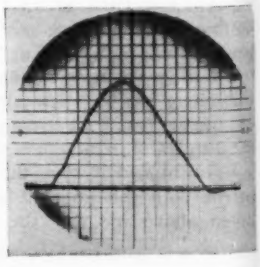

FIGURE 11
Time duration between dots equals 1 millisecond.

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utilize Z-axis modulation as illustrated in *Figure 11*. Basically, this consists of modulating the intensity of the beam trace with a signal of known frequency so that a series of dots denoting time intervals is superimposed directly on the pulse being produced. This has the advantage of displaying time directly upon the pulse and eliminating the necessity of measurement from a base line reference. The simplest method of doing this is to introduce a square wave of high frequency relative to the pulse being monitored through a simple differentiating network (a capacitor and a resistor) and then into the —Z axis of an oscilloscope. The result will be a series of dots as depicted in *Figure 11*.

Triggering

Since many shock phenomena are of relatively short duration, and usually require good resolution, a time expanded transient is useful. The problem of synchronizing scope sweep with the physical occurrence of the shock phenomenon can become tedious if not critical. By utilizing an adjustable micro-switch which is triggered by the falling table, the sweep can be accurately driven to display the shock pulse, and variations in drop height or table velocity can be compensated for by adjusting the height of the microswitch with respect to the table impact position.

A more sophisticated approach is to utilize a photocell or photomultiplier tube in conjunction with an adjustable time delay circuit. The falling table breaks a light beam, and, depending upon the height of drop or table velocity, the time delay can be set to "trigger" the scope sweep when desired so as to completely capture the transient phenomenon.

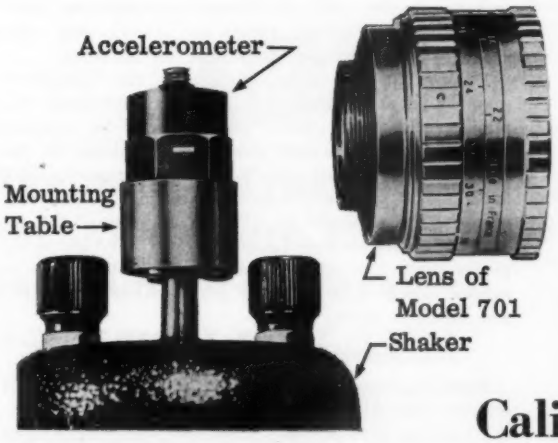
Mounting

Although not strictly in the realm of instrumentation, how the accelerometer is attached for shock testing can be extremely critical. A good secure bolt or stud arrangement is probably the most desirable. If, however, large accelerometers are tied down with small studs, there is a possibility of a relatively low frequency resonant system. It could appear as a ringing transient or distortion, depending upon the nature of the pulse being produced. In all probability, however, such effects would be more marked during steady state vibration than shock. The natural frequency of such a system can be theoretically calculated from

$$f_n = \frac{1}{2\pi}\sqrt{\frac{EAg}{W}}$$

where E=material modulus—psi, A=cross section of stud—sq. in., g=380 inch/second^2, l=acting length of stud and W=weight of accelerometer lbs.

Dental cement and certain epoxies are quite adequate for securing accelerometers at low temperatures, while certain commercial cements seem very good for normal room temperature use. Double back tape and non-setting cements or bonding agents should be used with extreme care since high magnitudes of shock or vibration involving high frequency components can be mechanically filtered by such tie-down means.



OPTRON Model 701 DISPLACEMENT FOLLOWER

Measures Vibration

To measure the displacement of an accelerometer, simply focus the spot of light from the Optron Model 701 on the edge of the accelerometer. It's that easy! **Frequency response**: Static to 7 kc. **Resolution** 12 micro inches.

Calibrates Accelerometers

Optron Model 701's interchangeable lenses provide five ranges: .050", .100", ½", 1" and 2" full scale. A heavy seismic stand provides isolation from the floor from 2 cps up. Model 701 never requires jigs or fixtures clamped to the work—it never makes contact with the specimen. It works on any material regardless of size, shape or composition—and it works in daylight!

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ENVIRONMENTS IN USE...

Prelude to a Successful Journey of the Ampex MR-100 Recorder

Late last year, a miniature tape recorder in a plastic container rode a Thor-Able nose cone 200 miles into space, reentered the atmosphere at a speed of more than 10,000 m.p.h. and was thrown free before it smashed into the Atlantic with an impact of 15 gs. Retrieved from the water nine days later, the unique recorder, Ampex Corporation's MR-100 performed perfectly.

Environmental evaluation of specific components and subassemblies of the rugged MR-100 was conducted throughout its development. The complete unit weighs only 20 pounds and occupies less than a fifth of a cubic foot. Its environmental specs are: 15 gs of shock, 75 gs of acceleration, 200,000 feet of altitude, 0° to 160° F. temperature and up to 95 per cent humidity.

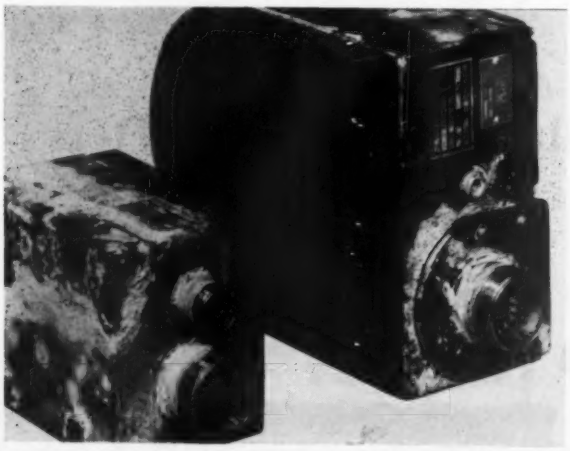
With no environmental laboratory of its own when the first engineering models of the MR-100 went into production, Ampex turned to outside sources for help. Shortly it did set up its own lab, however, with two altitude-humidity chambers, custom-built by Conrad, Inc., an oven, a vibrator and other equipment.

Every Unit Gets Assurance Test

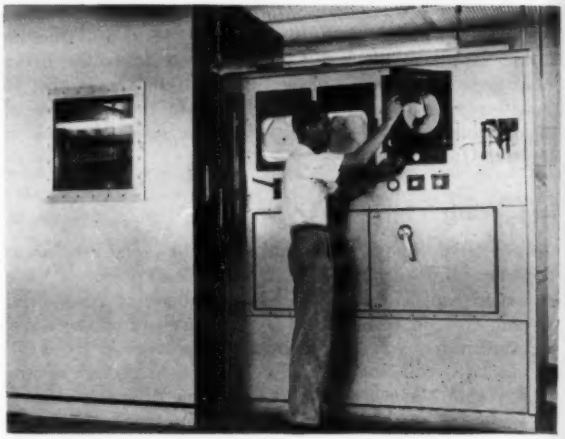
"No single previous project had so emphasized for us the importance of environmental testing," Ampex says. "Now a special operational assurance test is given all MR-100 systems before shipping, and a copy of the test results goes with each unit."

While the engineering models of the MR-100 were going through their environmental test paces, a complete record of performance was made by an Ampex Model 601, two-track laboratory recorder. Electrically, the MR-100 had to perform as follows:

Supply voltage—28-v. DC (± 5%) and 150-v. DC (± 5%); input level—2.5-v, peak-to-peak (.875-v. RMS) for normal record level; output level—2.5-v. peak-to-peak when reproducing 5 kc. recorded at normal level; harmonic distortion—1% third harmonic distortion at 500 cps (normal level); frequency response—± 3 db from 300 to 70,000 cps, down no more than 10 db at 100,000 cps; signal-to-noise ratio—RMS noise from 300 to 100,000 cps at least 30 db below reference or normal level at 5 kc; flutter—less than 2% zero-to-peak from .5 to 1000 cps.



The Ampex MR-100 recorder which survived a missile flight and nine days in the Atlantic. Acid burns from electrolyte of ruptured instrumentation battery did not affect performance.



Altitude chamber, especially built for Ampex by Conrad, Inc., is used for operational assurance tests of airborne and missile recorders.

High, Low Temperature Tests

For high temperature tests, the internal temperature of a temperature-altitude chamber was raised to 71° C., with relative humidity at not more than 5 per cent. Equipment under test was maintained at 71° C. for 16 hours, then lowered to 48° and operated on an 8-minute run, 8-minute standby cycle for 5 hours on alternate runs. The temperature then was raised to 71° C. and operation continued on the same duty cycle for an hour.

During the low temperature tests, the equipment was maintained at −18° C. for five hours. Returned to room temperature, the recorder was examined for deterioration or corrosion that would have spelled failure in the test.

Temperature shock tests saw the equipment maintained at 25° C. until performance stabilized. Then the temperature was dropped to −16° C., maintained for an hour and within 90 seconds raised to 71° C. When equipment performance had again stabilized, the temperature was returned to 25° C, ±15°, and performance of the recorder was checked again.

Humidity, Altitude and Vibration

Humidity tests were conducted at 49° C. and 95 per cent relative humidity for 48 hours. In a low pressure test, the internal pressure of the chamber was reduced to .257 mm. Hg (200,000' altitude) at an ambient temperature of 0° C. and maintained for one hour. A condition equal to 60 inches of mercury and a temperature of 71° C. was set up for the high pressure tests.

Most of the problems were experienced during vibration testing. The vibration requirements called for a cycle rate of 2.7 minutes per octave, of 1/2-inch double amplitude from 2 to 20 cps. The maximum gravitational force specified was 10 gs from 20 to 500 cps and 7 gs from 500 to 1,000 cps. The vibration cycle was broken up in such a way that a flutter carrier, recorded in the absence of vibration, could be reproduced during the vibration cycle for an accurate check. Flutter and carrier deviations were recorded at least once per octave of vibration.

Under preliminary vibration and shock tests, some

mechanical components were found to be too weak, and various electrical components shook loose or failed. Vacuum tubes in the reproduce circuitry presented the biggest problem. The reproduce amplifier is required to amplify a very-low level voltage from the reproduce head (10-20 microvolts). Although many types of subminiature and ceramic tubes of particularly low-microphonic characteristics were tested, none were found to be acceptable when subjected to the specified vibration.

Transistorization Was Indicated

The solution appeared to call for transistors, which are relatively insensitive to vibration. However, at the time, few transistors were in use in missile electronics, and complete transistorization of the amplifier with accompanying problems of input impedance and equalization, noise and frequency response did not seem practicable because of the project's urgency. After many attempts, a circuit was devised which consumed little power, had adequate signal-to-noise ratio, and was capable of reproducing the frequency spectrum. The circuit was transistorized except for one sub-miniature tube, retained as an output amplifier and cathode follower stage. This afforded a conveniently low output source impedance and made unnecessary changing the arrangement of the vacuum tubes used in other portions of the electronics assembly.

Packaging proceeded on the basis that the components, except the tubes, would be mounted on etched boards. Tubes were potted in a Dow-Corning compound which cures to a rubber-like substance with excellent heat-conducting properties. Protected in this way, the tubes tested satisfactorily under all environmental conditions.

Components mounted on the etched boards required similar protection against vibration. Accordingly, the boards were fastened to a heavy cast web, which fitted compactly into a mu-metal container, and the whole assembly was then protected by a heavy, cast aluminum case. However, motion was found to exist between components soldered to the etched boards. A silicon-base fluid, which does not harden completely, permitting the components to be removed and replaced when required, was the answer.

High Frequency Vibration Caused Redesign

High frequency vibration revealed another problem. The D-C governor-regulated drive motor, which was "hard"-mounted into the casting, was found to be operating considerably below the correct speed. The vibration was causing the governor contacts to open too soon. To isolate the motor from high-frequency vibration, redesign was required. This consisted of mounting the drive motor on rubber O-rings to drive a "hard"-mounted capstan, flywheel, and bearing assembly through a rubber coupling. Both the O-rings and coupling which isolate the motor were made of silicone rubber.

During linear acceleration tests, the equipment was placed in a Rucker centrifuge and mounted successively in six positions at the following accelerations: 75 gs (± 2 gs) along the single major axis of the component for one minute, and 15 gs along the other two orthogonal axes for 10 minutes.

Flutter and deviation were monitored during this test. The normal level at 1 kc had a maximum measured change of ± 1 db—within specifications.

Shock tests were applied with the equipment on standby. Three impact shocks of 30 gs (with a maximum of 6 milliseconds duration) were given in each direction along each of the three major axes.

An acoustic test subjected the equipment to one cycle of an acoustic field of 100 db at 150 cps, increasing to 130 db at 300 cps, and 130 db from 300 to 1,000 cps at a cycle rate of 2.7 minutes per octave. The equipment performed to specifications during the shock and acoustc tests.

AR★

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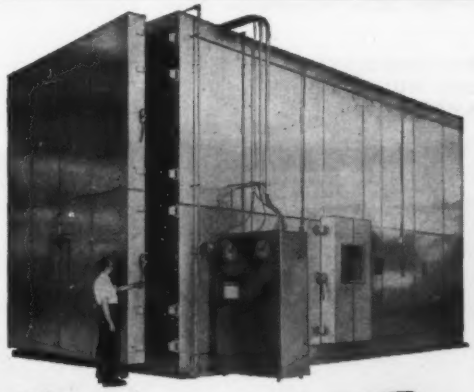
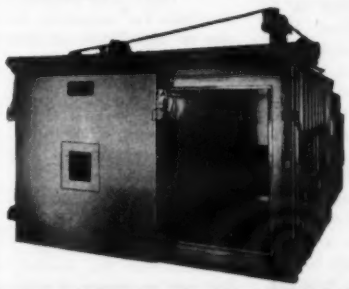
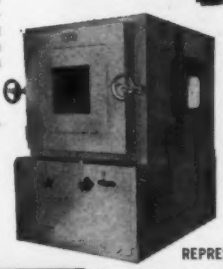


◀ Altitude, Temperature Humidity walk-in chamber 10′ high x 8′ wide x 12′ deep interior with push-button door controls inside and out.



Altitude chambers in any size — Altitude 200,000′ or higher; temperature +500°F and higher to −100°F and lower; Humidity 20% to 95%. ▶



▲ Prefabricated Temperature and Humidity walk-in test facility with test space 12′ x 25′ x 15′ high.

Sand and dust chamber ▶ includes automatic dust density control and stream-lined air-flow design.

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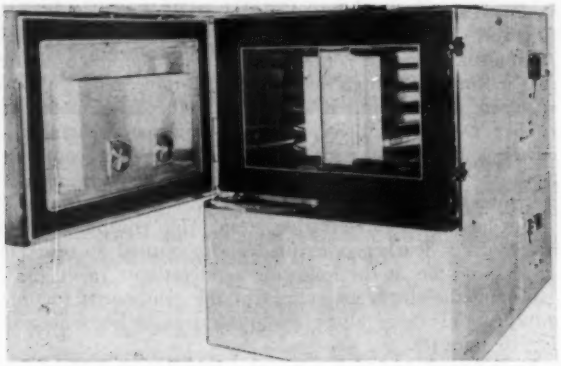
NEW PRODUCTS...

A "Reade: Service Card" requiring no postage is bound into this issue for the convenience of those desiring additional information on new products, new literature (Page 46) and other announcements. It is keyed in the text as "EQ RSC."

FAST CYCLING TEMPERATURE SHOCK CHAMBER



by **Tenney Engineering, Inc.**, switches from hot to cold in a range from —85° to +425° F. in only 10 seconds and recovers to the set point in but 20 minutes. Automatic programmer insures rapid cycling of electronic components and small assemblies without manual handling or shifting drawers. A special defrosting arrangement prevents coil ice-up during an indefinite period of low-temp testing. Measuring 5' x 7' x 8' deep, the chamber has a stainless steel heliarc welded interior with a work space 45" x 30" x 55", and is claimed capable of handling 25,000 transistors on test at one time. Same thermal shock design can be built into chambers from 3 cf to walk-in dimensions.

For More Information Circle EQ RSC #1

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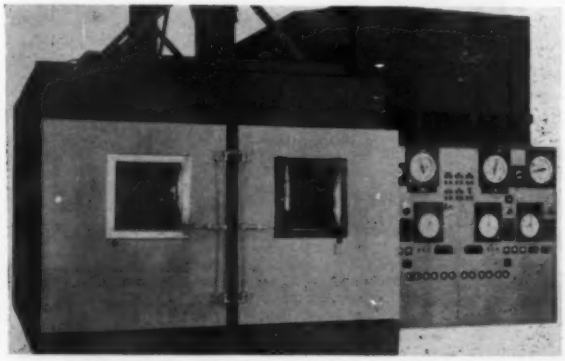
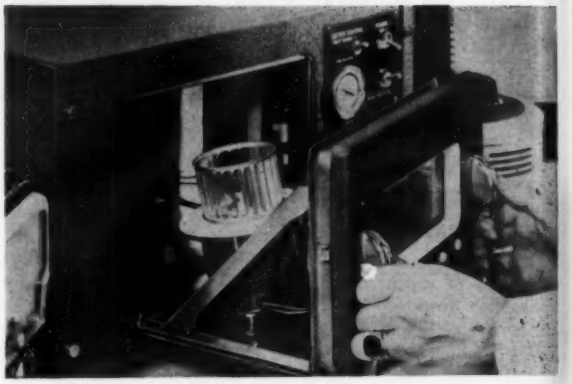
PARTITIONED TEMP. SHOCK HUMIDITY CHAMBER



Model WD-585-50-50-50-50 by **Conrad, Inc.**, has a power-operated partition to divide it into two independent test spaces as needed. Independent controls permit one half to be as high as +500° F. while the other is at —100° F. Accessory carts automatically transfer product load from one side to other. Automatic programming controls determine heating, refrigeration and humidity cycles. Gauges show equipment performance and indicating switches and timers permit visual recognition of control function. Humidity range is 20% to 98% from 35° F. dew point to 185°F. dry bulb.

For More Information Circle EQ RSC #2

ULTRA-RAPID CYCLING PORTABLE TEST CHAMBER



by **Delta Design, Inc.**, is said to complete a full cycle from —100° F. to 500° F. and back to —100° F. in slightly less than 10 minutes, with built-in overshoot prevention. Rack mounted, it has a 10" x 7" x 7" test volume, weighs under 50 lbs. and is cooled by liquid CO_2. A dynamic, thermocouple type control uses a special meter-relay circuit to maintain a claimed stability within ±½° F.

For More Information Circle EQ RSC #3

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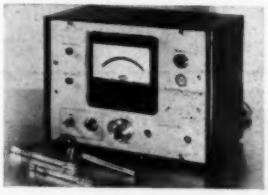
HIGH VACUUM GAUGE SENSING TUBES



by **Consolidated Vacuum Corporation** increase the versatility and adaptability of the Swedish LKB Autovac Pirani gauge, for which CVC is exclusive U.S. and Canadian agent. One tube, of Pyrex, was developed for direct sealing to glass systems and will withstand bakeout temperatures up to 400° C. Five inches long with a 10 mm o.d. and about 4 milliliter volume, it has two platinum-coated tungsten base pins for electrical connections. The other tube is of stainless steel, slightly thinner than the Pyrex one for installation in a metal system where breakage of corrosion is a problem. It is a half-inch longer and has twice the volume. The Autovac gauge provides continuous readings from 1 micron to 100 mm Hg.

For More Information Circle EQ RSC #4

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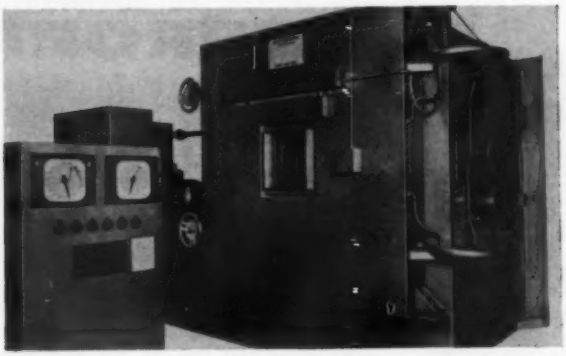
NEW PRODUCTS

WIDE TEMPERATURE RANGE TEST CHAMBER



by **American Research Corp.** is designed to simulate space conditions at any temperature and altitude up to 150,000 ft. Chamber produces temps ranging from —100° F. to +1000° F. by radiation from all six sides and by convection to simulate true, high altitude conditions around test specimen. The gradient is claimed to be held to ±5° F. The chamber has a free test space of 64 cu. ft., and is equipped with mechanical refrigeration capable of dissipating a heat load at the rate of 7500 watts at —70° F. View window in door can be used throughout the top temp range. Controls, recorders and penetrations supplied to customer specs.

For More Information Circle EQ RSC #5

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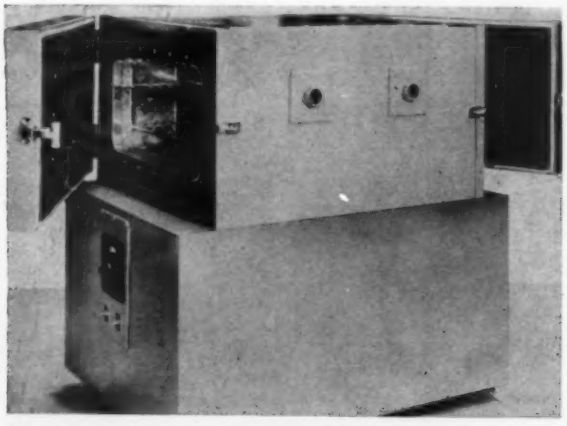
DUAL CHAMBER SUB ZERO CHILLING MACHINE



Model SU2-80-4 by Cincinnati Sub Zero Products allows testing or processing by operators located on both sides of the line. Each has access to a separate and individually controlled chamber, permitting two products with differing temperature requirements to be processed simultaneously. The chambers range down to -100° F. with cascade refrigeration systems and have thermal capacities of 500 BTU/hr at the minimum temperature. Galvanized interiors measure 12" x 24" x 17" deep, have two adjustable shelves, 1½" access ports and full opening doors. The entire unit measures 46" x 46" x 32" wide, is portable on four swivel rubber casters, and requires 230v 60c 1ph.

For More Information Circle EQ RSC #6

LOW-COST PORTABLE VIBRATION TESTER

called the **Rotocon by Rototest Laboratories, Inc.**, is intended for quality control analysis by plant personnel for exposing assembly defects or substandard parts of missile-borne components and equipment. Completely furnished and adjusted at the factory, it provides at the flip of a switch, a fundamental output vibration of 50 cps and overtones at predetermined multiples. A timer automatically turns it off after appropriate length of time. Unit features low operating and maintenance cost, simple data take-off and excellent sound proofing. It is claimed that six feet from the machine less than 75 db of noise can be detected.

For More Information Circle EQ RSC #7

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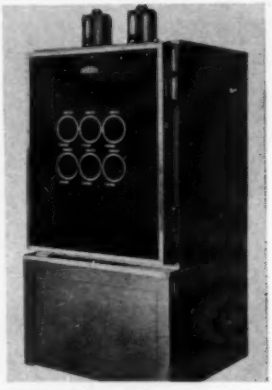
TEMPERATURE CALIBRATION CHAMBER



Model 6L-A220 by Harris Refrigeration Co., combines precision control with large thermal capacity. New standards are claimed for accuracy in temperature calibration. Point control of ±.1°C. in repeatability, speed of response and on-off differential plus temperature variation of less than 1°C. are provided. The single-chamber, 6 cu. ft. cabinet has a range from —20° C. to —85° C. and can recover completely in 10 minutes with 1000 BTU load at - 65° C. Two blowers for positive air circulation. Door can accommodate a wide variety of fixtures and jigs for holding parts under test. Door, cabinet trim, drip tray and interior are all stainless steel. Unit is protected against high pressure build-up or loss of refrigerant in a power failure.

For More Information Circle EQ RSC #8

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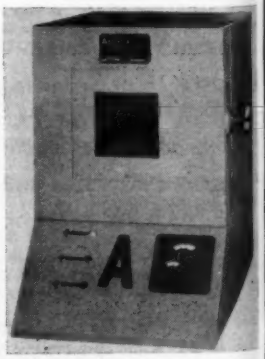
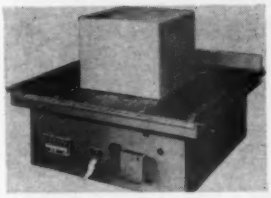
LOW COST, LOW-HIGH TEMP. CHAMBER



Econ-O-Line by Associated Testing Laboratories is an economical chamber using liquid CO_2 and spanning a range of -100° F. to +350° F., ±2°. It has a stainless steel, heliarc welded interior, 14" x 14" x 14", and a heavy steel enamel finish exterior. A two-inch port and plug is provided for leads and tubing. Priced at $735, it has an optional viewing window for $100 additional.

For More Information Circle EQ RSC #9

PRODUCTION LINE TRANSPORTATION SIMULATOR



Model 400-SVMC-3.5 by **L.A.B. Corporation** produces synchronous circular motion in a vertical plane to duplicate typical weaving, bumps, jars and accelerations of freight cars and trucks. Capacity of 400 lbs. enables a manufacturer to conduct the equivalent of a cross-country test on his product or packaging in one hour at the factory. Operates at fixed displacement of 1". With speeds from 150 to 300 rpm, it can develop slightly over 1 g. The variable speed drive units are self-contained within a 31" x 37" base frame below a 1" thick plywood table, 36" x 42". Overall height is 14". Frequency range is 2.5 to 5 cycles per second. Powered by ¾ hp, 220/440 3-phase 60c 1750 rpm motor. Continuously indicating AC type tachometer, interval timer and bypass switch optional.

For More Information Circle EQ RSC #10

* * *

MINIATURE GAS-DAMPED ACCELEROMETER

Model GMB by **Genisco, Inc.**, has an exceptionally constant damping output over a temperature range of −100° F. to +300° F. Output through a low noise wire-wound potentiometer in ranges from ±1 to ±30 gs is said to be accurate within ±1% for linearity, hysteresis and resolution. Frequency response is flat within ±5% to .4 of the natural frequency, and cross axis sensitivity is rated at not over .02g per g. Single cantilever spring supports the mass and provides high sensitivity along the sensing axis but resists loadings on the non-sensitive axes. Spring and seismic mass force gas through controlled leakage path providing constant damping over temp range. Unit is compact — 1¼" square by 2½" long — and light—5 oz. It is hermetically sealed, will withstand vibration of 10 gs to 2000 cps and shock of 50 gs and has a life in excess of 2 million cycles.

For More Information Circle EQ RSC #11

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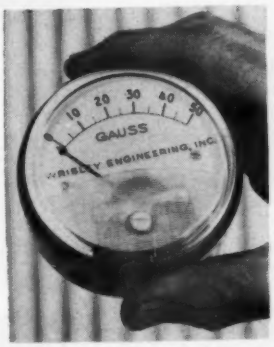
SIMPLE, HAND-HELD GAUSSMETER



Model G/M-50 by **Wrisley Engineering, Inc.**, measures stray magnetic field at critical specimen locations in conjunction with electrodynamic vibration systems. Small, rugged and inexpensive, it requires no power supply, electronics or external connections. Accuracy claimed is better than ±10% of the full 50 gauss scale. Weighs about 6 oz., is slightly bigger than a pocket watch. Price: $31.75.

For More Information Circle EQ RSC #12

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NEW PRODUCTS

WALK-IN ENVIRONMENTAL TEST ROOMS

in a new line by **Labline, Inc.**, have the unusual feature of being constructed in panel form and shipped knocked down for easy access through narrow doorways. Rooms come in a number of stock sizes, are easily assembled and come in two temperature ranges: ambient to +140° F. and 0° to +140° F., with accuracy within ±1°. Constructed of heavy-gauge aluminum inside with corrugated aluminum floor plates, rooms have an inside working height of 7 feet. Other available dimensions are 6' x 6', 6' x 8', 6' x 10', and 6' x 12'. All have a 12" square viewing window, fluorescent lighting and lifetime lubricated exhaust fans and adjustable shelving.

For More Information Circle EQ RSC #13

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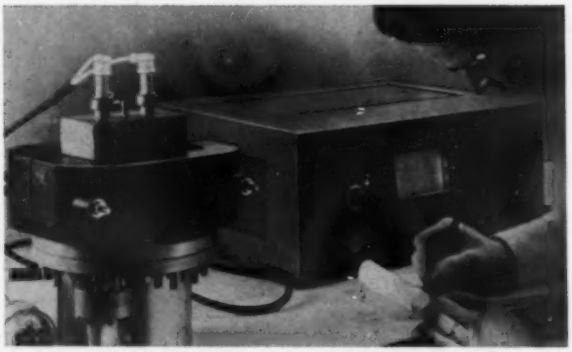
HIGH SPEED VACUUM ION PUMP



Model PDV-30 by **Consolidated Vacuum Corporation** is the first in a new line called **DriVac**, designed to achieve a higher ratio of pumping speed per unit volume and more stable pressure. Claimed speed is five times faster, size for size, than any other vacuum ion pump. Speeds per second of 25 liters for air, 8 for argon, 28 for methane and 15 for hydrogen, remain constant over the entire pressure range without any saturation or falling off with time. A "sputtering cathode" provides three-electrode construction to enhance speeds and eliminate pressure surges. Pressures down to 1 x 10^{-10} mm Hg can be obtained. The stainless steel pump will withstand 450°C. baking temperatures. Pump, magnet and power supply occupies only 18 sq. in., stands 8 inches high and weighs less than 90 pounds. Priced at $1630.

For More Information Circle EQ RSC #14

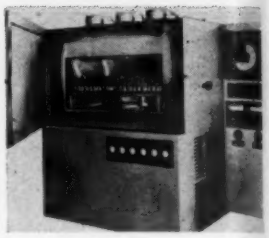
* * *

RUGGED ELECTRICAL VACUUM GAUGE

Model SP-3 by **Hastings-Raydist, Inc.**, is said to be the first to cover the range of 10-200mm Hg absolute. It offers direct pressure readings through a rugged thermopile, unaffected by atmospheric changes or exposure. Freedom from outgassing, system contamination, corrosion and rust is obtained by use of a noble metal thermopile and nickel plated tube. The clear dial face is exponentially calibrated, giving 15-30 center-scale readings.

For More Information Circle EQ RSC #15

ADVANCED CHAMBER FOR SEMICONDUCTORS



Model WF-12-125+400 by **Webber Manufacturing Co., Inc.**, is said to remove 7,270 BTU from product load in 15 minutes with cascade condenser mechanical refrigeration. Intended for R & D on dentritic semiconductors and other applications requiring precise and accurate controls, the chamber can lower a 90 lb. load from +355° F. to −85° F. in 29 minutes, and reverse the change in similar time. Full range is −125°F. to +400°F. Stainless steel interior, 44" x 24" x 19", is pressure tight and has controlled nitrogen flow. Instrumentation is programmed, visible, indicating, adjustable, and recording. Selector switch indicates temperature of product load, or three additional temperature zones.

For More Information Circle EQ RSC #16

* * *

HIGH TEMPERATURE INDICATING CONTROL

Type E36N by **United Electric Controls Company** is a compact remote bulb instrument with a double-pointer single scale ranging from 100° to 1000° F. Suited for ovens and test equipment. Available in three models with three sensing bulb styles.

For More Information Circle EQ RSC #17

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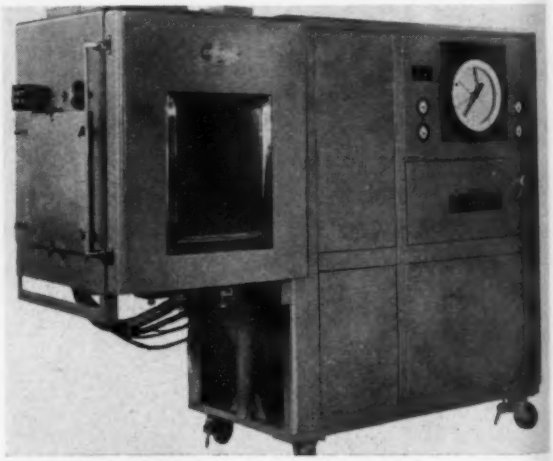
COMBINED TEMP.— VIBRATION TEST CHAMBER

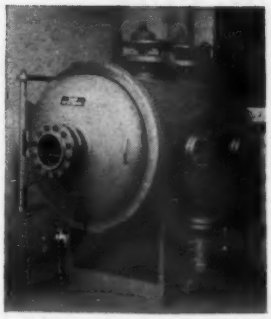


Model FBV-8-3-3 by **Conrad, Inc.**, has a hydraulic hoist for various shaker heights and can accommodate vertical or horizontal vibrator. Vibration access ports are sealed with a flexible silicone diaphragm during vibration test or are plugged when temperature only is being used. Temp ranges are −100° to +300° F. or, on order, +100° to +500° F. Interior size is 26" x 26" x 24" deep. Various diameter conduit ports up to six inches are available, as are gauges for the Freon 13 Freon 22 refrigeration system, and indicating or recording controllers. Mounted on heavy-duty 5-inch wheels with locks, the chamber can be adapted readily for use above a slippery table.

For More Information Circle EQ RSC #18

EXPLOSION-PROOF TEST CHAMBER

Model X3050 by Itemco, Inc., is designed for temperatures to 200° F. and altitudes to 100,000 ft. Door and body are certified to withstand 300 psi explosive force, obtained by igniting propane gas or high octane gasoline, and are said to withstand 450 psi under hydraulic test. Multipoint switch provides sequential step operation. A sampling chamber permits ignition checking without destruction of the main test chamber atmosphere prior to operational tests. The chamber is completely equipped with temperature, altitude



and fuel mixture controls, along with relief valves that automatically compensate for altitude. Meets MIL-E-5272-C specs.

For More Information Circle EQ RSC #19

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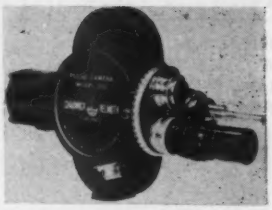
SELF-ELEVATING TEMP.-VIBRATION CHAMBERS

Series TE-100 by Wyle Manufacturing Corp., test missile and aircraft components at high and low temperatures in conjunction with vibration along all three axes. Optional hydraulic lift positions chamber over vibration exciters or oil-film vibration slip tables. Bottom of chamber has holes patterned to match vibration heads, and the whole bottom panel may be removed for use over slip tables. One entire side is hinged for access, and additional ports provide access for instrumentation, specimen actuation lines or slip plates.

For More Information Circle EQ RSC #20

FAST PULSE CAMERA FOR VIBRATION TESTING

Model 370 by Chadwick-Helmuth Company operates at 30 frames per second, almost double C-H's previous record-speed 16mm model. For vibration test movies, auxiliary SLIP-SYNC equipment permits slow motion recording of cyclic events at 10,000 cps. Equipped with a shutter for conventional pulse camera work, it can be quickly changed to open-shutter operation with



slaved strobe lights. Unit holds 100 ft. of film. Price with lens, $1,850; SLIP-SYNC accessory about $2,000. Delivery, 30-60 days.

For More Information Circle EQ RSC #21

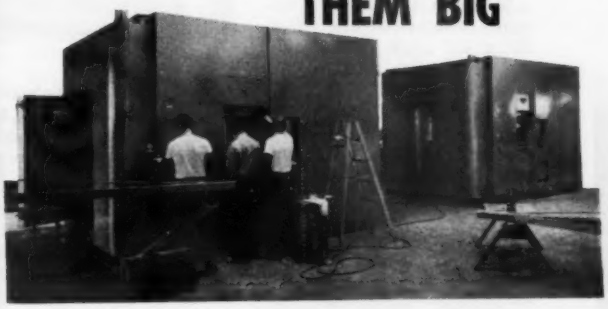
* * *

PORTABLE PRECISION TEMPERATURE CHAMBER

Model 7000A by Delta Design, Inc., for rack-mounted electronic equipment in 19½ x 11 x 15-inch stainless steel interior. Said to provide very accurate temperature controls. Can make prolonged runs from -100°F. to +500°F. with stability within ½°F. achieved by a thermocouple and a precision meter-relay. Optional auxiliary timer can be preset for automatic hot-cold cycling through the chamber's range. Aluminum cabinet, finished in gray crackle, has Pyrex window and port for feed-through connectors. Cooling is by liquid CO_2.

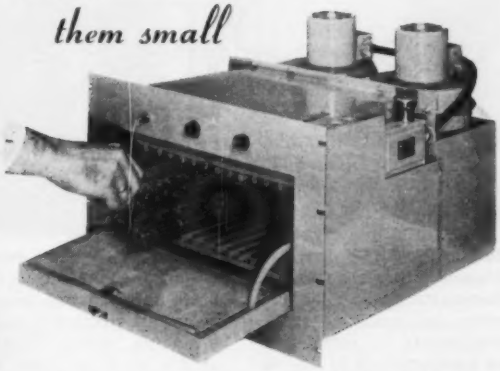
For More Information Circle EQ RSC #22

BEMCO BUILDS THEM BIG

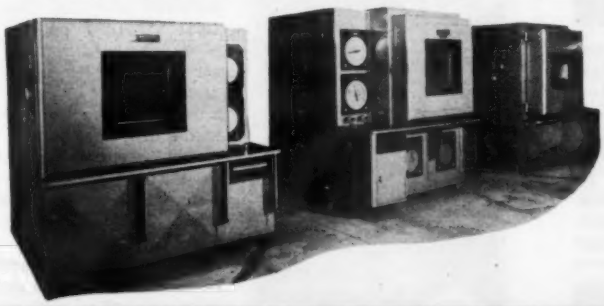


BEMCO INC.

Bemco builds them small



BEMCO BUILDS THEM MIDDLE SIZED



All sizes for any test work with temperature, pressure, vacuum, sand and dust, salt spray, explosion, sunshine, rain, humidity, fungus, and combined environments.

BEMCO INC. • 11631 VANOWEN STREET • NORTH HOLLYWOOD, CALIF.

NEW PRODUCTS

HIGH VACUUM SYSTEMS: LOW PRESSURE, FAST PUMP

Models LC1-14B and LC1-18B by Consolidated Vacuum Corporation produce ultimate lows of 2 x 10-6 mm Hg. The first model has a 14-inch Pyrex chamber and reaches a working pressure of 5 x 10-4 mm Hg. in 3 minutes with a 4-inch PMC diffusion pump and a 13-cfm mechanical roughing pump. The other chamber, 18-inch diameter, can reach 1 x 10-4 in 5 minutes with a 6-inch diffusion pump and the same roughing pump. The assemblies are built into steel cabinets with removable vented panels, giving quick access to the pumping system and electronic circuits. Many optional accessories are available.

For More Information Circle EQ RSC #23

* * * *

PORTABLE HOT-COLD TABLE TOP CHAMBER

by Electric Hotpack Company, Inc., provides quick test of single subassembly, leaving larger chambers free for long range test programs. Range —100° to +400° F., ±1° over the full range. High velocity blower disperses CO_2, producing minimum temp in minutes. Controls include indicating-controlling thermostat and high-low wattage switch. Lift-out drawer has thermocouple openings for monitoring during tests. Baked enamel finish with stainless steel interior.

For More Information Circle EQ RSC #24

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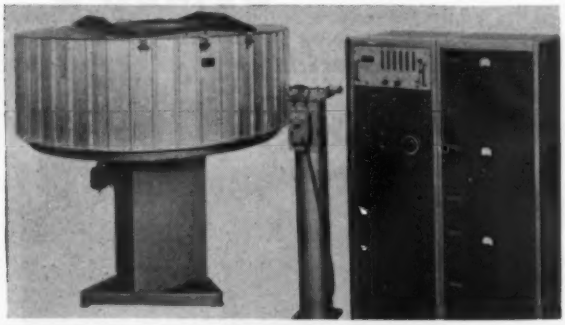
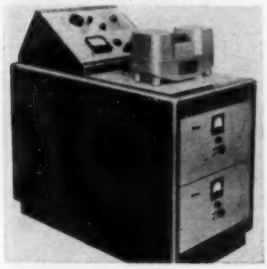
PRECISION CENTRIFUGE WITH MINIMUM DRIFT



Model A931 by Genisco, Inc., subjects ultra sensitive accelerometers, inertial platforms and guidance system components to very accurate accelerations in discrete steps. Long-term drift claimed is less than one part per million per week. RMS deviation from average angular velocity calculated at less than one part in 50,000. Range from .5 to 20 gs (25 to 180 rpm) and arm angular velocity is variable in 10 steps. Magnetic pulse system monitored on an electronic counter measures speed. Capacity: 25 lbs., in a 12" cube. Complete unit consists of rotating arm in an aerodynamically-clean housing, electronic radius comparator which translates into speed any arm radius variation, and an electronic control rack.

For More Information Circle EQ RSC #25

PORTABLE VIBRATION TEST SYSTEM



Model LCM 1200 by LCM Engineering features a horizontally moving shake table, push-pull driven and supported on air bearings. The air stiffly confines the action of the table in all directions except the axis of excitation. Primarily designed for production test of such small components as transistors, vacuum tubes and relays, the system can also be furnished for r & d or accelerometer calibration. Accessory equipment permits automatic programming to meet Mil-Std 202A, Method 204. Systems with 50 force pounds rated output are available in sweep frequency ranges of 5 cps to 5 kc or 20 cps to 20 kc, or may be modified to customer requirements.

For More Information Circle EQ RSC #26

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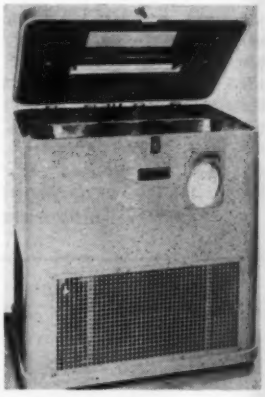
MULTIPURPOSE ULTRA LOW TEMPERATURE CHAMBER



Model A-120-5 by Cincinnati Sub Zero Products is adaptable to metallurgical applications or special test requirements. A convection fluid can be used for production chilling of small parts or mechanical air convection used with an air circulator in the lid when special testing requires minimum temperature variation and close temperature control. Completely portable on four swivel casters, it has an operating range from +70° down to —130° F. Exterior dimensions are 40" x 32" x 44" high, with interior, 30" x 18" x 16" deep. Construction is all-steel unitized and the exterior is grey lacquer. Requires 230v 60c single phase. Maximum operating efficiency at nominal cost is provided through a cascade refrigeration system. Accessory features include a window, lights, indicating-recording controller, and heaters for hi-temp tests.

For More Information Circle EQ RSC #27

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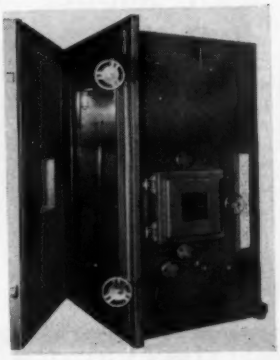
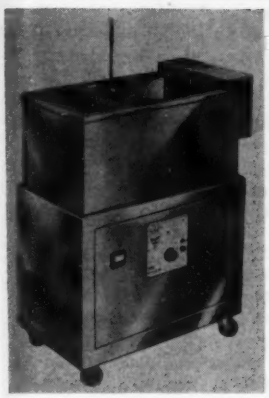
DIRECTIONAL AIR-ALTITUDE-TEMPERATURE TEST CHAMBER



by American Research Corporation provides true vertical air flow on the test piece in one direction only, air returning to the top of the walk-in chamber via a rear plenum. In free test space of 4' x 4' x 7½' high, chamber simulates altitude to 100,000' and higher and temperatures from —100° to +350° F. Unique feature is a small, reach-in side door which makes it possible to check the test piece quickly between cycles without opening the main door.

For More Information Circle EQ RSC #28

PORTABLE REFRIGERATED BATH



Magni-Whirl by **Blue M Electric Co.**, equipped with Power-O-Matic 60 saturable power reactor control, has built-in overtemperature protection. Range: 0° C. to 100° C. using stable fluids and 5° C. to 100° C. with water. Control has no contacts, moving parts or auxiliary mechanisms to wear, burn or arc. Automatic compressor pump down evacuates system; below ambient refrigeration system permits compressor to run continuously. Double-wall type construction (18-8) stainless steel. Inner tank heliarc welded. Ball bearing casters for mobility. Mercury-type thermometer provided.

For More Information Circle EQ RSC #29

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VIBRATION TEST SYSTEMS

Series 80 by **Unholtz-Dickie Corporation** permit starting with 1,350-lb. system and, as force requirements increase, adding amplifiers or purchasing a large amplifier to produce 2,500 lbs. or, with an even larger exciter, 5,000 lbs. The systems are said to be fully competitive in performance and total cost at each step of the expansion. Four systems are available in the series, all with shaker, amplifier and control cabinet, plus various accessories. Controls can be automatic or manual. The deluxe systems have automatic frequency cycling and will sweep the frequency range at an adjustable rate, reversing at settable highs and lows, maintaining constant table displacement in the low ranges and switching to constant acceleration in the higher ranges. Axial resonance is above 3,000 cps in the shaker, which is the same for all four systems.

For More Information Circle EQ RSC #30

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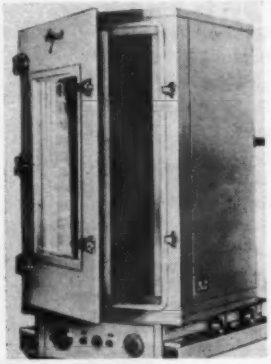
STRESS TRIAL OVEN



by **Electric Hotpack Company, Inc.**, permits continual heating of test materials during stress measurement trials through a temperature range of 35° C. to 150° C. Accuracy claimed is ±.5° C. Unit rolls in and out of stress tester, has ceiling and floor openings for stress tester jaw clamps. Includes wattage selector switch, automatic thermostat over-temperature cut-off and remote recorder. Heat distribution by forced air circulation.

For More Information Circle EQ RSC #31

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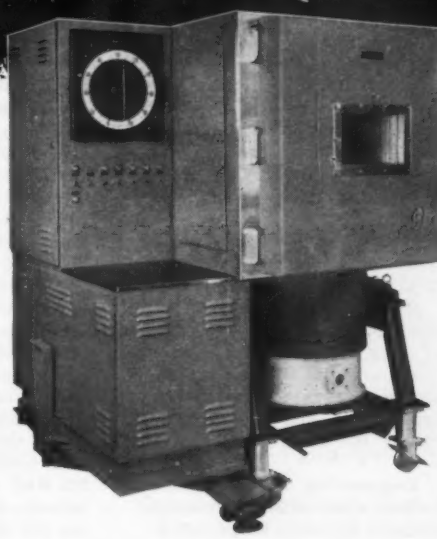
RANDOM VIBRATION CONTROL SYSTEM

Model 1011 by **Genisco, Inc.**, is a versatile instrument to apply and accurately control random vibration in combination with any power amplifier and electrodynamic shaker. It can also be used as a signal generator and monitoring device to provide shaped or compensated power distribution for amplifiers to drive high intensity sound testers.

For More Information Circle EQ RSC #32

COMBINED ENVIRONMENT TESTING

vibration
temperature
altitude
humidity



- temperature, altitude, humidity ranges to your requirements
- vibration in any plane
- may be designed to accommodate existing vibration equipment
- may be used with or without vibration

Murphy & Miller Series LTUV Environmental Test Cabinets are complete, self-contained units incorporating advanced design and operating features to provide users with an efficient, trouble-free test medium. The LTUV Cabinet may be used with or without the vibrating unit. Stainless steel test space, indicating type controls and optional equipment like cabinet self-elevation, recorder controllers, programmers with automatic percentage capacity control make these Cabinets the preferred test units used by discriminating researchers.

Write for complete details on this and other Murphy & Miller Environmental Test Equipment.

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600 West Taylor Street
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ENGINEERING REPRESENTATIVES IN ALL PRINCIPAL CITIES

LITERATURE FOR ENVIRONMENT...

Endevco Corporation, Pasadena, Calif., describes its new doughnut-shaped accelerometer, Model 2221, which can be screw-mounted or cemented in odd corners or next to bulkheads, in a two-color foldup bulletin **(Circle EQ RSC #38).** It also offers a three-page technical pamphlet, ring-punched, on its unique, subminiature transistorized amplifier. Frequency response charts and typical circuitry are included. **(Circle EQ RSC #39).** Endevco also gives details of its Dyna-Monitor system for monitoring and amplifying vibration, shock, pressure and force signals in a third bulletin. **(Circle EQ RSC #40).**

* * *

Industrial Acoustics Company, New York, has published new data on acoustical and structural characteristics of reverberant rooms for measuring total sound power, output of equipment, sound power level comparisons and absorption coefficients. The data includes typical applications and ready reference charts **(Circle EQ RSC #41).**

* * *

Tenney Engineering, Inc., Union, N. J., offers a six-inch plastic ruler to engineers, without charge, showing the 1959 ARDC atmosphere table relating pressures and temperatures up to two million feet. **(Circle EQ RSC #42).** Tenney also has a one-page flyer highlighting its new hyper-environmental space simulator which ranges up to a half-million feet and 1200° F. Other unusual chambers, including one for the man-in-space program are also illustrated and described briefly. **(Circle EQ RSC #43).**

* * *

Barry Controls, Inc., Watertown, Mass., has a four-page brochure on its much-discussed RIGIDAMP system of controlling vibration by laminates or cell-insert construction. In non-technical language it explains the theory of the system and shows product application. **(Circle EQ RSC #44).** Barry also offers literature on the specifications and capabilities of its VARIPULSE shock testing machines **(Circle EQ RSC #45);** giving details and oscillograms on its popular Type 16750 shock machine **(Circle EQ RSC #46);** and single page spec sheets on its all-direction shock and vibration isolators, Series 5200, **(Circle EQ RSC #47)** on its miniature Ballmounts, Series 275, 302 & 372 **(Circle EQ RSC #48),** and on its powerful Cupmounts, Series 1000, **(Circle EQ RSC #49).**

Pure Carbonic Company, New York, offers a 24-page ring-punched booklet on carbon dioxide. Liberally illustrated, it traces its early history, explains its manufacture in the gas, liquid and solid forms and outlines various types of supply systems and applications, along with accessory equipment and controls. **(Circle EQ RSC #50).**

* * *

Consolidated Vacuum Corporation, Rochester, N. Y., has prepared a well-illustrated six-page Bulletin 8-15 on its line of oil-sealed rotary vacuum pumps which apply the building-block principle to attain speeds that increase uniformly from size to size. Tables of condensed data and dimensions are included **(Circle EQ RSC #51).** In Bulletin 4-1, CVC describes a series of new vacuum equipment and accessories, including a four-inch pumping system, auxiliary leak test station, 10-port manifold system and cathode ray tube aluminizer **(Circle EQ RSC #52).**

* * *

Cardox Division of Chemetron Corporation, Chicago, explains the advantages of carbon dioxide systems for fast cooling and absolute control in a new booklet featuring pic-

PRECISION CONTROL + SUPER THERMAL CAPACITY

with New Harris Temperature Calibration Chamber

Point control of ±.1° C. in repeatability, speed of response, and on-off differential is provided by this new Harris Environmental Chamber, Model 6L-A2-20. 6 cu. ft. chamber with temperature variation of less than 1° C. Temperature range of —20° C. to —85° C. Complete recovery in ten minutes with 1000 BTU product load at —65° C.

Air circulation positively controlled by two blowers in a specially designed plenum chamber. Door accommodates a wide variety of fixtures, or may be inexpensively modified for any requirement. Door and cabinet trim, drip tray, and interior all of #304 stainless steel.

Machine fully protected against high pressure build-up or loss of refrigerant should electric power or water fail. Starts automatically when services are restored.

Users report that this machine is setting new standards for accuracy in temperature calibration. Write to see how it can do the same in your plant.

HARRIS MANUFACTURING CO., INC.

312 River St., Cambridge 39, Mass.

MEMBER OF ENVIRONMENTAL EQUIPMENT INSTITUTE

Pioneer in refrigeration service, engineering, and manufacturing since 1934.

tures and diagrams of principal methods of use. **(Circle EQ RSC #53).**

• • •

MB Electronics, New Haven, offers an "optical wedge," a pressure sensitive sticker, which, when affixed to an object under vibration test, helps to measure displacement **(Circle EQ RSC #54).**

• • •

Unholtz-Dickie Corporation, Hamden, Conn., has a 14-page bulletin describing shakers, power supplies, controls and accessories of systems from 1,250 to 2,500 pounds generated force, developing up to 100 g. The Series 80 features the building-block concept of starting with a low-priced model with manual controls and 850 pounds rated force which can be expanded to 2,500 pounds as need develops. **(Circle EQ RSC #55).**

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Cincinnati Sub Zero Products, Cincinnati, describes and illustrates its large capacity production chilling equipment for environmental testing and other purposes in a new bulletin. Specifications are given on temperature ranges, thermal capacities, dimensions and other data for various models. **(Circle EQ RSC #56).**

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Hastings-Raydist, Inc., Hampton, Va., has a six-page folder showing its principal heated thermopile vacuum gauges and giving ranges and special features of each model. It also describes the principle of operation and construction of the gauges. **(Circle EQ RSC #57).**

• • •

National Research Corporation, Cambridge, Mass., offers a quick rundown on its new space vacuum laboratory in an illustrated technical data sheet. Its chambers can simulate orbit altitudes in excess of 500 miles. **(Circle EQ RSC #58).**

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Chadwick-Helmuth Company, Monrovia, Calif., has printed data available on appliction of its 16mm pulse camera to slow-motion movies of destructive resonances in vibration tests. **(Circle EQ RSC #59).**

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Consolidated Electrodynamics Corp., Pasadena, Calif., offers a 16-page general catalog on its transducers, accelerometers galvanometers, ceramic and precision optical products. **(Circle EQ RSC #60).**

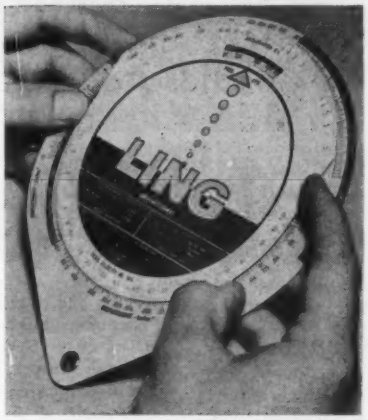
• • •

B & K Instruments, Inc., Cleveland, present a detailed and technical analysis of the automatic recording of amplitude density curves of non-periodic noise in a 20-page pocket-size booklet. **(Circle EQ RSC #61).**

Directory of GSE Agencies Published

A revised edition of a directory of military agencies responsible for developing missile ground support equipment is available through the Office of Technical Services, Business and Defense Services Administration of the Commerce Department. The publication, PB 161535, costs 50 cents.

Calculations Made Easy



Ling Electronics has devised a "Dialor" to simply calculations of both sinusoidal and random vibration levels. The relations between displacement, velocity and acceleration can be determined precisely by rotating a wheel. Given the frequency and one function, an engineer can obtain the magnitudes of the other two. *(Circle EQ RSC "C".)*

Cryogenic Conference Aug. 23-25

The 1960 Cryogenic Engineering Conference, co-sponsored by the National Bureau of Standards and the University of Colorado, will be held in Boulder, Col., Aug. 23-25.

ELECTRONIC SPEED CONTROL EXCLUSIVELY ON RUCKER SMALL CENTRIFUGES

The new electronic speed control circuit—an exclusive feature on Rucker Series I Centrifuges, provides: Digital Control Setting: Only one setting required to reach any desired speed • Programmed Sequence or Remote Operation • G Rating Repeatability • Dependable, Quiet Operation • Fast Test Cycle • Automatic or Programmed Dynamic Braking

OTHER RUCKER FEATURES:

- Easiest Access to Specimen and Instrumentation
- Minimum Wow and Drift Through High Inertia Design
- Heavy Steel Construction Throughout for Maximum Safety
- Electrical Slip Rings
- Capacities to 15,000 G Pounds, 92 Inch Diameter
- 90° Specimen Rotation During Operation (Procedure I under MIL-E-5272A)—(Optional)
- Wave Guides for all Applications (Optional)
- Closed Circuit TV (Optional)
- Hydraulic-Pneumatic Rotary Joints (Optional)

THE RUCKER COMPANY Since 1941

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ATTENTION: Openings now for Qualified Engineers—for Design and Sales

ENVIRONMENTAL BUSINESS...

Shamroth, Bruskrud Take Over EEI Helm; New Seal Is Adopted

Jack Shamroth, president of the American Research Corporation, Farmington, Conn., was elected president of the Environmental Equipment Institute at the annual meeting in Los Angeles in April. *(For a statement of Mr. Shamroth's views on the role of the EEI, see "Post Scripts.")*

Shamroth

At the same time, the members of the EEI, trade association of the environmental industry, elected Warren R. Bruskrud, president of Bemco, Inc., North Hollywood, Calif., as executive vice president, and named the following to the executive committee for the 1960-61 year:

Monroe Seligman, president of Tenney Engineering, Inc., Union, N. J.; Richard B. English, executive vice president, Murphy & Miller, Inc., Chicago, and E. S. Brown, president, Standard Cabinet Co., Carlstadt, N. J.

Bruskrud

Dr. George D. Wilkinson was reappointed general manager of the EEI, with offices at 9 Spring Street, Princeton, N. J.

Mr. Shamroth, the new president, is a veteran of nearly two decades in the environmental industry. He succeeds Charles C. E. Harris, president of Harris Refrigeration Co., Cambridge, Mass. Election as executive vice president places Mr. Bruskrud in line for the presidency next year.

In other actions at Los Angeles, the Institute backed a move to set up a standard environmental terminology *(EQ, April, 1960, Pg. 8)*, named an awards committee consisting of Alexander Newman, president of the Hudson Bay Co., Chicago, chairman; Mr. English and Angelo Lazzara, vice president, Blue M. Electric Co., Blue Island, Ill., planned an intensified membership program, authorized an advertising campaign and adopted a new emblem.

Seligman

English

Seal of Approval Program

The emblem plays a part in the EEI's seal of approval program, an original major undertaking of the group. Its purpose, according to Dr. Wilkinson, is to "let purchasers know that they can buy our products with confidence" and that of non-members, too, "because the specifications set forth by EEI members are standards of comparison."

Before a company can become a member, the seal of approval program requires that it satisfy the EEI on three counts:

(1) That it has a successful record of at least two years as a manufacturer of environmental equipment.

(2) That it has engineers and technicians capable of producing the equipment to be sold.

(3) That it has sufficient financial backing to be able to make good on guarantees and warranties.

How the Program Works

When a customer thinks an EEI member has sold him faulty equipment, his first step is to complain to the vendor. Such complaints usually clear up the misunderstanding, according to Dr. Wilkinson, but in a few cases, customers who felt they did not receive satisfaction from the local representative of the manufacturer have contacted EEI headquarters.

"In accordance with our procedure," Dr. Wilkinson added, "I relayed the complaints to the members in question. In every case where this occurred, the vendor settled the matter to the complete satisfaction of the customer. In each case, the original difficulty was based on a misunderstanding, or resulted from faulty communication. The good offices of EEI were sufficient to solve the problem."

The program provides, however, for additional steps to be invoked if necessary. The general manager may appoint an investigating committee of at least three members—not including the one involved in the complaint, and the committee may go so far as to inspect the equipment in dispute.

Persuasion is Next Step

Then it would try persuasion to bring about an agreement. This failing, the committee can make a formal finding and, if the EEI member were deemed at fault, it can specify what he must do to make good.

Should the member remain adamant, the case would go to the EEI executive committee, which can make its own findings and recommendations. A member who still would not make good would be dropped from the EEI.

"The customer," Dr. Wilkinson points out, "is, of course, not bound by the action of the investigating committee. Should the committee find against him, he would have the satisfatcion of knowing that his case has been judged by reputable competitors of his vendor. If he disagrees with the committee, he, like the vendor, can take the matter to the executive committee of the Institute.

Final Steps Never Invoked

"No customer has ever had occasion to invoke the last two steps of the procedure. I do not think I shall ever appoint an investigating committee. Both the members of EEI and their customers are responsible parties, and I feel that restoring communications between them will always be sufficient to solve their problems.

"It is important to point out that EEI is a trade association in which membership is voluntary. For this reason, the force behind the seal of approval program must be persuasive. EEI cannot force a member to take any steps he is not legally obligated to take. On the other hand, no manufacturer would willingly risk being censured by his competitors."

A First at Rototest

Rototest Laboratories, Lynwood, Calif., has installed the first independent laboratory random vibration facility utilizing the latest Ling analyzer-equalizer system. Unknown variations can be analyzed at a glance and spectrum shifts equalized while the test is in progress. (Circle EQ RSC "H.")

Ling-Altec, Barry Plan Merger Moves

Two major companies in the environmental industry are in the midst of merger actions.

Ling-Altec Electronics, Inc., leader in the field of vibration and acoustics, is planning a consolidation with Temco Aircraft Corp., to form Ling-Temco Electronics, Inc.

Barry Controls, Inc., manufacturer of shock testing equipment and shock and vibration isolators and suspension systems for defense and sonsumer products, has moved to merge with The Wright Line, Inc., to form the Barry-Wright Corporation.

Final decision on both merger actions now rests with the stockholders of the espective companies.

Ling Slated for Presidency

As planned, James J. Ling, chairman and chief executive officer of Ling-Altec, would become president of Ling-Temco, with Clyde Skeen, Temco's executive vice president, taking the executive vice presidency of the new concern. Robert McCullogh, president of Temco, is to become chairman and chief executive officer.

Under the Barry-Wright plan, Ervin Pietz, president of Barry Controls, would become president and chief executive officer of the new company, with R. P. Collins, president of the Wright Line, heading the board of directors.

Tenney Engineering Posts Price Increase Up To 7½%

Price increases of up to 7½ per cent were posted May 1 by Tenney Engineering, Inc., Union, N. J., one of the country's oldest and largest makers of environmental test chambers. Robert H. Brown, vice president, attributed the increases to "higher material costs and the more exacting demands being made on our engineers to simulate environments considered fantastic a few years ago."

Mr. Brown said the price rise was reflected in both standard catalogue equipment and custom units, but that outstanding quotations were honored according to the terms of the bid.

News of Test Labs

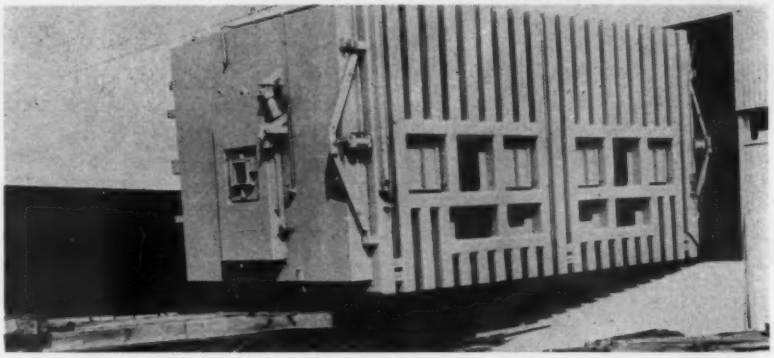
(For further information on any of the announcements below, simply write the name of the lab on the "other" line of EQ's Reader Service Card.)

Calibration Service Offered

Due to mounting requests by government agencies that test equipment show calibration in terms of National Bureau of Standards references, *United States Testing Company, Inc.*, Hoboken, N. J., is offering the following service:

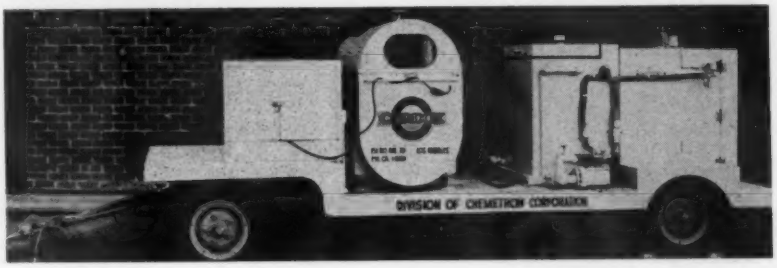
Certificate guaranteeing that equipment has been compared to appropriate standards; data log sheet of calibration at various points of the equipment scale; seal attached to equipment showing date

Environments on the Move

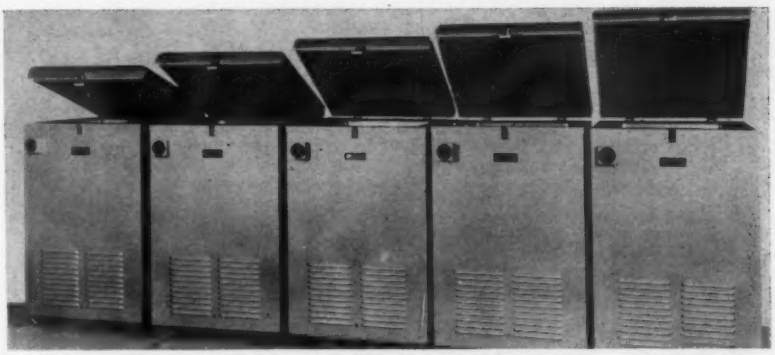


One of the largest test chambers—14'x12½'x28' overall—ever moved overland in one piece went recently via low-bed trailer truck from American Research Corp., Farmington, Conn., to a New England R & D firm. Normally three hours, the trip took two days. Chamber data: —100° to +350° F., 150,000' alt., 10x10x24 free test space, fully automatic. (Circle EQ RSC "D.")

Broken up for shipping, this prefabricated sectional chamber is claimed by Conrad, Inc., Holland, Mich., to be the world's largest, with 6,500 cf test space. Four flat cars moved it to a West coast missile maker. Chamber data: —85° to +300° F., 20% to 98% humidity, vertically rising doors both front and back. Center partition permits setting up two different sets of conditions. (Circle EQ RSC "E.")



Warm reception is reported on the West coast for this touring demonstration of ultra-cold testing with CO2 by the Cardox division of Chemetron Corp. Second unit from the front of trailer is low pressure bulk carbon dioxide tank. One of the two test chambers at the rear is cooled by sublimation, the other by direct injection. (Circle EQ RSC "F.")



Typical recent foreign shipment by Cincinnati Sub-Zero Products are these low temperature chambers for medical research. The company has opened a separate export office at its Cincinnati, Ohio, headquarters, with H. E. Schurgast in charge. (Circle EQ RSC "G.")

The 40 liter/second Vaclon® High Vacuum Pump, emphasized above, is just one of a great variety of Varian Vaclon Pump sizes available from stock. These include ½, 1, 5, 40, 100, 140, 280, 1000, 3000, 5000 and 10,000 liter/second capacities. Other sizes available on custom order.

All these pumps give extremely clean vacuums to below 10^{-10} mm Hg, have no moving parts or fluids, and operate without attention or service.

The Vaclon High Vacuum Pump is a fully electronic device and is a Varian "First." Unique both in principle and advantages, it has been accepted as an efficient, reliable laboratory and production tool by industries throughout the world.

A comprehensive brochure and technical data sheets are available by writing Vacuum Products Division.

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Welcome to Acton

George E. Pihl (right), president of Acton Laboratories, Inc., Acton, Mass., a subsidiary of Technology Instrument Corp., greets Herbert Cohen, manager of Acton's new Space Instrumentation division. The division is offering a complete service, from basic ideas through design, environmental testing, supervision of flight through telemetry checkout and production of recoverable packages. Joseph R. Frissora is the division's chief engineer, and James L. King its design engineer. Both were formerly at the AF Cambridge Research Center. (Circle EQ RSC "I.")

of certified test, and tag attached to equipment showing date of last test and due date of next.

The service, available on contractual or as requested bases either in-plant or at U. S. Testing, is applicable to such measured parameters as current, voltage, resistance, inductance, capacitance, frequency, temperature, specific gravity and volume.

American Laboratories Grows

American Laboratories division of American Electronics, Inc., is adding 10,000 square feet to its 2½-year-old structure at Fullerton, Calif. The lab recently added one of the largest liquid CO_2 distribution systems for cold chamber testing on the Pacific coast.

Another recent acquisition is a sand drop shock tower, believed to be one of the largest on the coast. Built by Propulsion Development Laboratory, Santa Monica, Calif., it can handle loads up to 1,200 pounds and fully meets the requirements of MIL-S-4456.

Wiggins Facilities Available

The environmental test facilities of *Wiggins Connectors,* Los Angeles, previously used only for the company's own products, are now available commercially. J. A. Minor, vice president, marketing, said the lab has been expanded "to handle all phases of aerospace testing" and "to take care of a backlog of testing requirements from other manufacturers."

Acquires Second Eastern Lab

A second Long Island test laboratory has been acquired by the *Wyle* organization of El Segundo, Calif. Earlier Frank S. Wyle had bought Parameters, Inc., New Hyde Park, N. Y., and renamed it Wyle Parameters. Then he announced acquisition of Burgoyne Testing Laboratories.

ITEMCO
ENVIRONMENTAL
TEST EQUIPMENT

ITEMCO Makes Chambers for:

MEMBERS E.E.I.

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LOW TEMPERATURE
HIGH TEMPERATURE
ALTITUDE
HUMIDITY
SALT SPRAY
SAND and DUST
VACUUM OVENS
WALK-IN ROOMS

ITEMLAB INC.
The Nation's Most Complete
Environmental Testing Laboratory

ITEMLAB Tests...

SINUSOIDAL AND RANDOM VIBRATION
(5 TO 5000 CPS FROM −120° TO +600° F AT 200,000 FT. ALTITUDE) (WITH AUTOMATIC CONTROLLING, PROGRAMMING AND RECORDING)

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(WITH DIRECT RECORDING)

HIGH-LOW+1200° F TO −120° F TEMPERATURES
(AT ALTITUDES TO 200,000 FEET)

MISSILE SHOCK ACCELERATION TESTING
(SAWTOOTH—SINEWAVE—SQUAREWAVE)

SALT SPRAY • FUNGUS • EXPLOSION
SAND & DUST • HUMIDITY • RAIN
SUNSHINE • ROTARY ACCELERATION
SHIELDED ROOM FACILITIES
QUALIFIED PERSONNEL

BEECHWOOD AVENUE
PORT WASHINGTON,
NEW YORK

Typical American Set-up

A set-up for vibration tests at American Laboratories, Fullerton, Calif., is typical of the use of the lab makes of its new CO_2 distribution system. Said to be one of the most complete on the West coast, the system was designed and installed by Cardox division of Chemetron Corp. It includes a 22-ton mechanically refrigerated and pressurized storage area and 28 individual outlets. (Circle EQ RSC "J.")

Inc., Westbury, N. Y., now known as Wyle-Burgoyne, Inc.

Aerotest-Technik Affiliation

Aerotest Laboratories, Inc., Deer Park, N. Y., and Technik, Inc., Garden City, N. Y., have announced a working affiliation. Lee Permut and H. J. Shapiro, principal officers of Aerotest, which specializes in functional, qualification and environmental testing of electronic, mechanical, pneumatic, hydraulic, avionic and fuel system equipment, said the arrangement gives their firm advanced research and development facilities.

Idaho Maryland Mines Acquisition

Idaho Maryland Mines Corporation has acquired Testing, Inc., Los Angeles, and renamed it *Universal Research and Testing Laboratories.* Elmo T. Evans has been appointed general manager, Charles Adamovic, chief test engineer, and James McGonigal, customer relations manager.

New Cryogenic Facilities

Expansion of its special fastener-testing facilities with cryogenic and elevated temperature chambers has been announced by *Almay Research & Testing Corp.,* Los Angeles.

IRE Group Visits Rototest

Several hundred members of the Southern California chapter of the IRE visited Rototest Laboratories, Lynwood, Calif., last May in an IRE program for quality control engineers.

REMPE
Heat Transfer Equipment

PRECISION
FABRICATED
PIPING

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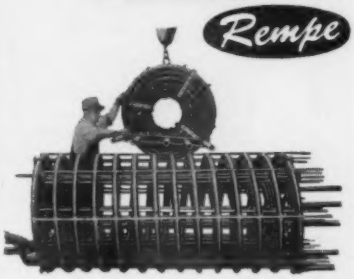

From Any Workable Material

Coil illustrated is a Custom Engineered multiple spiral assembly fabricated from 1½" IPS extra heavy Inconel. Similar units can be fabricated for any application from Stainless Steel, Nickel, Copper, Aluminum or any other workable material required for the job.

FURNISH DETAILS FOR QUOTATION

STAINLESS STEEL
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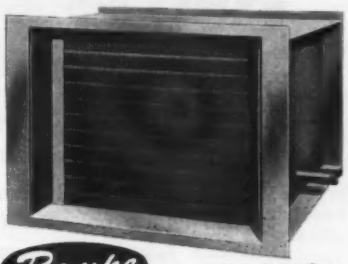

Rempe Solves Corrosion Problems!

Many industrial and chemical plant processes require that acid vapor laden air be heated or cooled for further treatment—Rempe Fin Type Heating Coils of stainless steel are the most economical solution. They can be furnished with gas-tight casing as illustrated, or standard style with exposed headers.

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WE'LL FIND THE ANSWER

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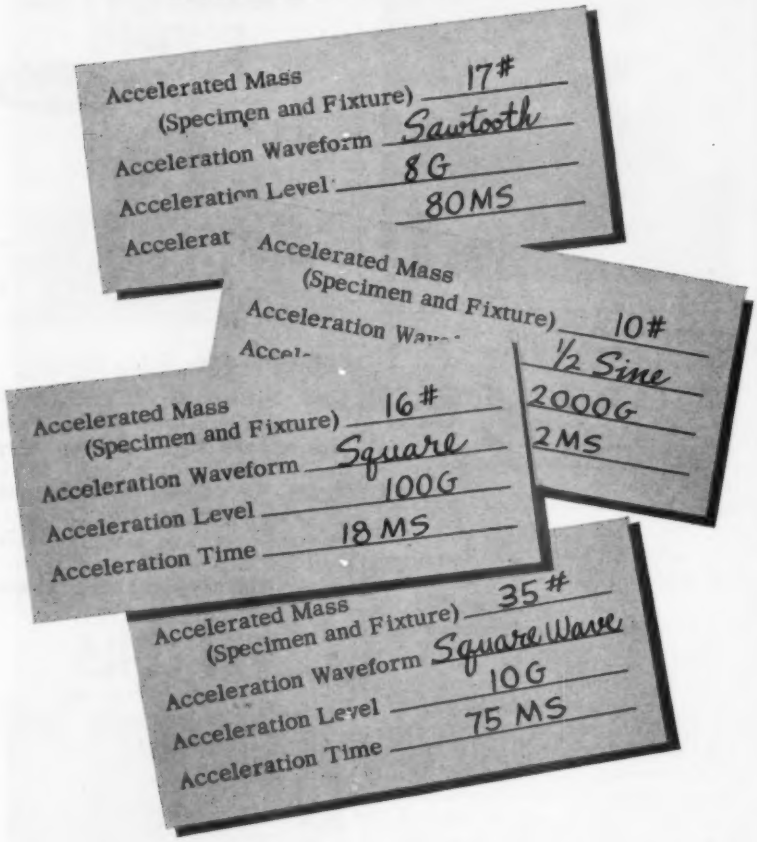
Shock Tests only HYGE can perform reliably... repeat reliably



11 MS ½ sine, 6 MS sawtooth, 10 MS square . . . these are typical shock pulses frequently encountered in today's military specifications and routinely tested with CVC HYGE. Military specs also call for many special shock waveforms which have been accurately performed and repeated only with HYGE. A few of these are shown above.

Choose from 3 HYGE models . . . laboratory or production line . . . with thrust capacities up to 40,000 lbs. force . . . and acceleration to 2000 G. Each features HYGE's unique adaptability to the widest range of shock tests, to meet your present and *future* shock test needs.

Write for HYGE Bulletins, or outline your requirements and we'll make a recommendation.

Consolidated Vacuum Corporation

ROCHESTER 3, NEW YORK

Aerospace Division Organized by Tenney

An Aerospace division has been set up at Tenney Engineering, Inc., Union, N. J., environmental chamber manufacturer, "to coordinate the Company's advanced state-of-the-art research and development and to initiate new programs." Monroe Seligman, president of Tenney, said the new division is available for contract assignments.

Mr. Seligman named Dr. Bruno Sachs Tenney's vice president for engineering to head the Aerospace division. He said emphasis will be "on the tremendous problems of outer-space simulation" and "extreme environments in combination." *(Circle EQ RSC "N.")*

Conrad Announces 'Space Environment' Chambers

A new series of "space environment" test chambers has been announced by Conrad, Inc., Holland, Mich. The series includes standard sizes from 2-foot diameter by 2½ feet deep to 3, 4 and 6-foot diameters by 5 feet deep.

Standard equipment includes mechanical and diffusion pumping systems and vacuum pumping capabilities to .5 of a micron, or about 350,000 feet altitude. *(Circle EQ RSC "O.")*

General Testing in New Home

General Testing Laboratories, Inc., has occupied new and expanded quarters at 46 Commercial Ave., Moonachie, N. J. The lab, now headed by Dr. Alan F. Surosky, president, and Dudley A. Hill, executive vice president, was formerly associated with Standard Cabinet Co. in Carlstadt, N. J.

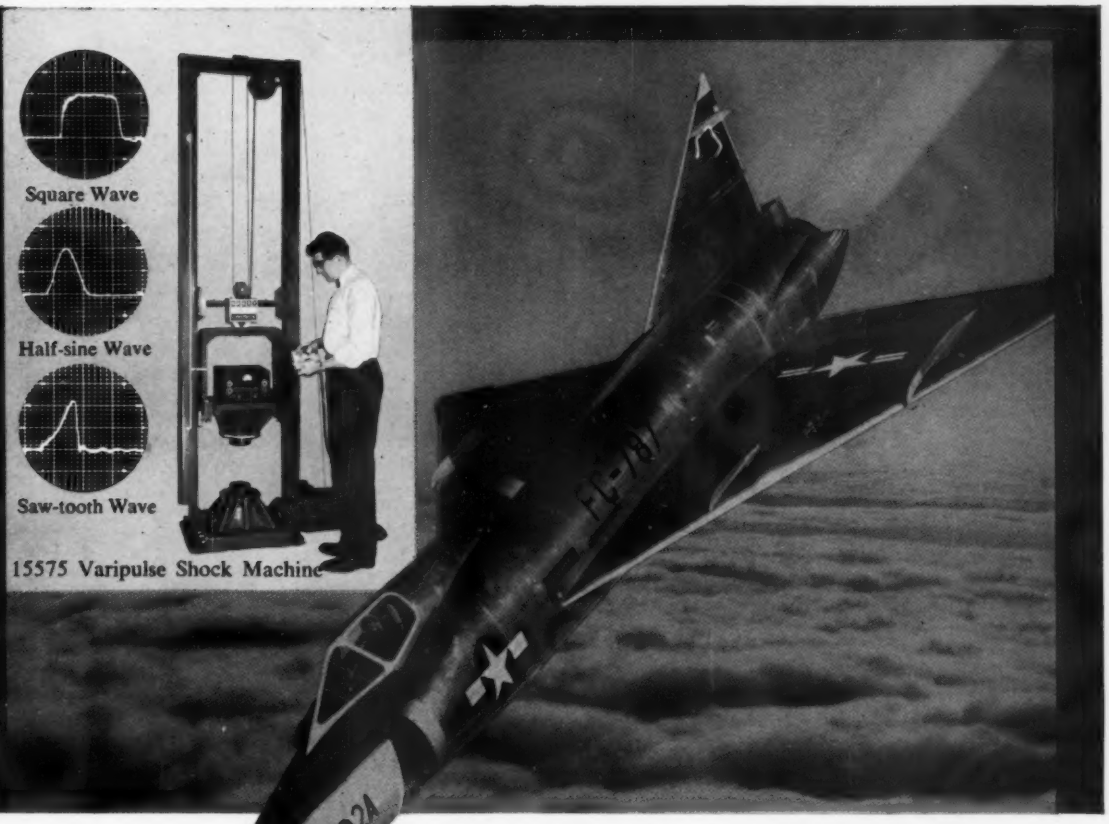
Now, Equipment Leasing, Too

Equipment leasing, a growing means of financing expansion out of income rather than capital outlay, is now available in the Environment. Industrial Acoustics Company, Inc., New York, has announced a lease plan in connection with its anechoic rooms, acoustic doors, jet ground run-up silencers and other soundproofing installations. *(Circle EQ RSC "A".)*

PAM Designs New Equipment To Quiet McClellan's Jets

To reduce jet warmup noise at McClellan Air Force Base, Sacramento, Calif., PAM Associates, Baltimore specialists in noise control and acoustic and vibration equipment, is designing suppressors to cut sound pressure levels to 1/1000th of those experienced with existing equipment at the field.

According to Edward J. Kirchman, PAM's president, the new design will reduce sound pressure levels to a range of 60 to 80 db in an octave band frequency of 150 to 9,600 cps. A feature of the equipment is that water is "weeped" rather than sprayed to cool after-burners, reducing water consumption to less than 80 gallons per minute. The equipment will be many times smaller than conventional installations. *(Circle EQ RSC "B".)*



SHOCK TESTING

(FOURTH OF A SERIES)

Early in 1957, Barry Controls started development of a new shock testing machine, specifically intended as a precise laboratory device for testing the smaller components in the growing field of avionics. From this program emerged the 15575 Varipulse.

Versatile and precise, this machine produces exactly repeatable saw-tooth, half-sine, and square waves through independent control of magnitude of peak acceleration, time duration, and pulse configuration. Tests are precisely repeatable with the same machine and exactly reproducible on a different Varipulse, permitting a uniformity of results no matter which agency performs the test.

The entire series of Varipulse machines is designed to eliminate resonances, and electronic circuit filtering is minimized, together with the filtering inherent in the instrumentation. Confusion of the validity of output through a filtering network is eliminated.

The standard 15575 Varipulse takes specimens up to 100 pounds in a 15-inch cube. Half-sine waves are produced by dropping on a rubber pad; saw-tooth and square waves are generated by using shaped lead pellets as the arresting medium. For the half-sine pulse, positive locks are used to catch the rebounding table at the peak of rebound.

Tests are fast, simple, safe, and require no special personnel training. Set-up time is negligible; cycling time is only 30 seconds. A remote control requires the use of both hands in making the test drop; dual pushbuttons actuate a positive-hold solenoid-release toggle. Additional safety features are the disconnect interlock and the elevator safety lock.

The 15000 Varipulse accommodated loads to 400 pounds; the 15575 Varipulse took loads of 100 pounds. To span the intermediate range, Barry designed the 16805 Varipulse to handle loads to 200 pounds, in a cube as large as 24 inches.

Both the 15575 and 16805 Varipulse Machines are designed for ease of installation. They require no auxiliary thrust devices, are calibrated at the factory, and are shipped completely assembled. Only 110-volt a-c power is needed for hoist and release.

But components were becoming smaller, and in 1959 the demand became apparent for a simple machine that could serve as a production-test device for smaller components such as relays. Barry engineers undertook solution of this problem and designed the already-popular 16750 Varipulse.

(To be continued)

Write for "Shock Testing of Airborne Electronic Equipment" by Charles E. Crede

Leaders in Shock Simulation

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because the Tenney 3 environmental test chamber will move, in that length of time, from ambient to either −40°F or +200°F. And extremes of −120°F and 350°F take just a little longer. There are also variations of the T-3 to meet every temperature and load dissipation need, every budget. Humidity environment is available as a standard option. All have cascade refrigeration system; single electrical connection. Perfect for testing electronic components, instruments, military qualification specs, and for metal aging, shrink fitting, tool chilling, liquid baths, preservation of pharmaceuticals, and hundreds of other testing and production jobs. For more information on the T-3 and other units, write today to:

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OLDEST AND LARGEST MANUFACTURER OF ENVIRONMENTAL EQUIPMENT